POWER

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Industrial Power

BEFORE the use of electricity became general, it was difficult to know how much power a plant was generating or how the power was distributed among the different departments.

In many industries the cost of power was such a small item in the total expense that executives gave it little attention.

The records that engineers talked about and by which the performances of engines were known, were those of the large waterworks engines where the output was easily measurable and the power the total expense.

With the coming of the central station where power is the whole output, increased attention was paid to efficiencies and possible methods of reducing the cost of power production.

This and the mounting cost of fuel and other items of power cost have encouraged the operators of industrial plants to investigate some of the possibilities of recent developments.

Improvements in boiler-furnace design, mechanical methods of feeding the fuel, whole or pulverized, make possible large increases of efficiency and of capacity. High pressures and temperatures make it possible to run engines or turbines against high back pressures at the same steam rate that they ran condensing, making the exhaust available at no extra cost for heating and process work.

Superheat makes possible exhaust steam that is devoid of moisture, and the turbine provides an exhaust that is free from oil.

If an industrial establishment has use for a limited quantity of exhaust steam, it may, by the use of sufficiently high pressures and temperatures and highly efficient prime movers, be able to generate its required power on the amount of steam required for heating and processes.

The bleeder turbine and the multi-stage engine permit steam to be taken off for other than power purposes at any pressure, while the rest goes on to the condenser.

The cheapest way to generate power known to man is to use the prime mover as a throttle valve between a high-pressure and a low-pressure system. If the low-pressure system can absorb all the steam passed down from the high and return its condensate to the boiler, the efficiency of the cycle is one hundred per cent.

And the process may approach one hundred per cent utilization because even the radiation often serves a useful purpose.

This issue of *Power* is largely devoted to power in the industries. We shall be glad if it inspires attention to and discussion of the large possibilities in that direction.

F. R. Low

Combined High-Pressure Power and Heating Plant

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A PULVERIZED-COAL boiler plant furnishes steam at 380 lb. per sq.in. to a turbine exhausting into heating mains at pressures from 5 to 15 lb. per sq.in. gage, with supplementary live-steam service for heavy demands.

AFTER a careful investigation of the possibilities for central-station heating in the business district of Rochester, N. Y., the Rochester Gas & Electric Corporation decided last fall to build a new steam-generating plant and distribution system intended ultimately to cover the business district of the city.

A study of costs led to the choice of 380 lb. per sq.in. pressure, the steam to be passed through a non-condensing turbine and reheated to from 20 to 40 deg. superheat before delivery to the low-pressure system.

The distribution system consists of high-pressure and low-pressure lines with a return line for the condensation from the heating customers. The low-pressure system is designed to take care of approximately 80 per cent of the maximum demand when the outside temperature drops to zero. The other 20 per cent will be supplied through the high-pressure system by means of reducing valves at the far ends of the systems. This method reduces the investment in the low-pressure system and gives a relatively inexpensive method of taking care of peak loads of short duration.

The high-pressure and low-pressure steam pipes and return lines are inclosed in a concrete duct. Both steam lines are insulated with a laminated type of all-asbestos insulation, the return line being left bare. In addition to these three pipe systems, a single low-pressure line has been built through a district requiring low-pressure steam only.

A tract of land was purchased near the center of distribution, large enough to accommodate a final plant double the size of the plant now being built. This tract runs from one street to another, and the second half of the plant will be practically a duplicate of the first, permitting receipt of coal at either end of the plant.

The present plant is approximately 62 ft. wide by 113 ft. long, and provision has been made for installing two boilers at present, a third unit in the future, considerable substation equipment, and space for two turbines. The turbines will be located in the basement, one of these machines (a 3,000-kw. unit) to be installed at present and the second unit in the future. The building stands approximately 80 ft. high.

The boilers are a recent design of high-pressure units, each boiler containing 9,580 sq.ft. of boiler-heating surface, with sufficient integral economizer surface to bring the total to 11,220 sq.ft. Each boiler is made up of eight unit sections in width, reduced to six units wide on the rear section of the boiler proper, and six economizer units. Each boiler is designed to deliver a maximum of 120,000 lb. of steam per hour at 380 lb. per sq.in. pressure. Superheaters are installed, designed to give about 125 deg. superheat.

Economizers having 4,707 sq.ft. of surface, are installed above the boilers. They are of the baffled type, and the gases pass from the economizer to an induced-draft fan with double motor drive. A 15-hp. motor drives the fan up to about 20 per cent of boiler rating. Above this rating a 75-hp. motor will drive the fan up to 400 per cent of boiler rating. Slip-ring variable-speed motors are used, driving the fan through spur gears. The smaller motor is in gear at all times, and a magnetic clutch is provided between the large motor and the gear so that it is disconnected except at the high rating. When the smaller motor is driven above synchronous speed, it will be automatically disconnected from the line by a reverse power relay.

The economizer is somewhat novel in that it is designed to carry a maximum of only 15 or 20 lb. per sq.in. pressure. The discharge headers of the economizer are connected to a drum in which is a float controlling the water admitted to the economizer and designed to maintain a constant level in the drum. This drum is vented to the low-pressure steam distribution system so that any steam generated in the economizer will be taken off in this way.

The boiler-feed pumps are between the economizer and the boiler, taking their water from the economizer drum under about 30-ft. head. Feed-water regulators control the admission of water to the boilers.

Powdered-Coal Equipment

The necessary unit mill pulverizing capacity is provided to drive these boilers to 400 per cent of capacity. Each boiler is provided with one 2,000-lb. mill and two 7,000-lb. mills. The small mill has the exhaust fan built in as an integral part of the mill, but in the case of the 7,000-lb. mills the exhauster is separate from and mounted just above the mill, together with the feeders for the large mills. The mills are provided with constant-speed alternating-current motors and the exhausters with slip-ring variable-speed motors. The firing will be vertical, one burner being provided for the 2,000-lb. mill and two burners for each of the 7,000-lb. mills. The burner for the small mill is on the center line of the boiler with the burners for the large mills located symmetrically about the center line, to give a uniform flame distribution in the furnace with any of the mills in operation.

The furnaces have a total volume of approximately

10,000 cu.ft., or about 0.9 cu.ft. per 10 sq.ft. of boiler-heating surface. A design developed by the author is used in the construction of these furnaces, these being made up of special brick, the side walls and the arch construction proper being built out of the same brick.

As indicated in Fig. 1, the front and back walls are vertical. The lower two to three feet are built of ordinary firebrick, and above this point the walls are entirely of the special brick. As indicated in Fig. 1A, the lower 16 ft. of the side walls are corbeled in toward the furnace, the remainder of the side walls being vertical. The front portion of these walls is 30½ ft. high, and on the sides back of the arch, 41½ ft. The design of the brick used is such as to provide for contraction and expansion, and repairs may be made at any point without disturbing the remainder of the wall. Six-inch I-beams carry the weight of the walls, in vertical sections 32 in. high, each section carried on an angle clip riveted to the I-beam. Any one of these 32-in. vertical sections can be removed without disturbing the one above or below it. Special asbestos millboard will be clamped to the outer flanges of the 6-in. I-beams, to provide a space between the brick and the millboard, through which air will be circulated and preheated before going to furnace or pulverizing mills.

A novel feature incorporated in the design of the arch proper is shown in Fig. 1. The horizontal portion of this arch is rigidly supported by 4-in. I-beams,

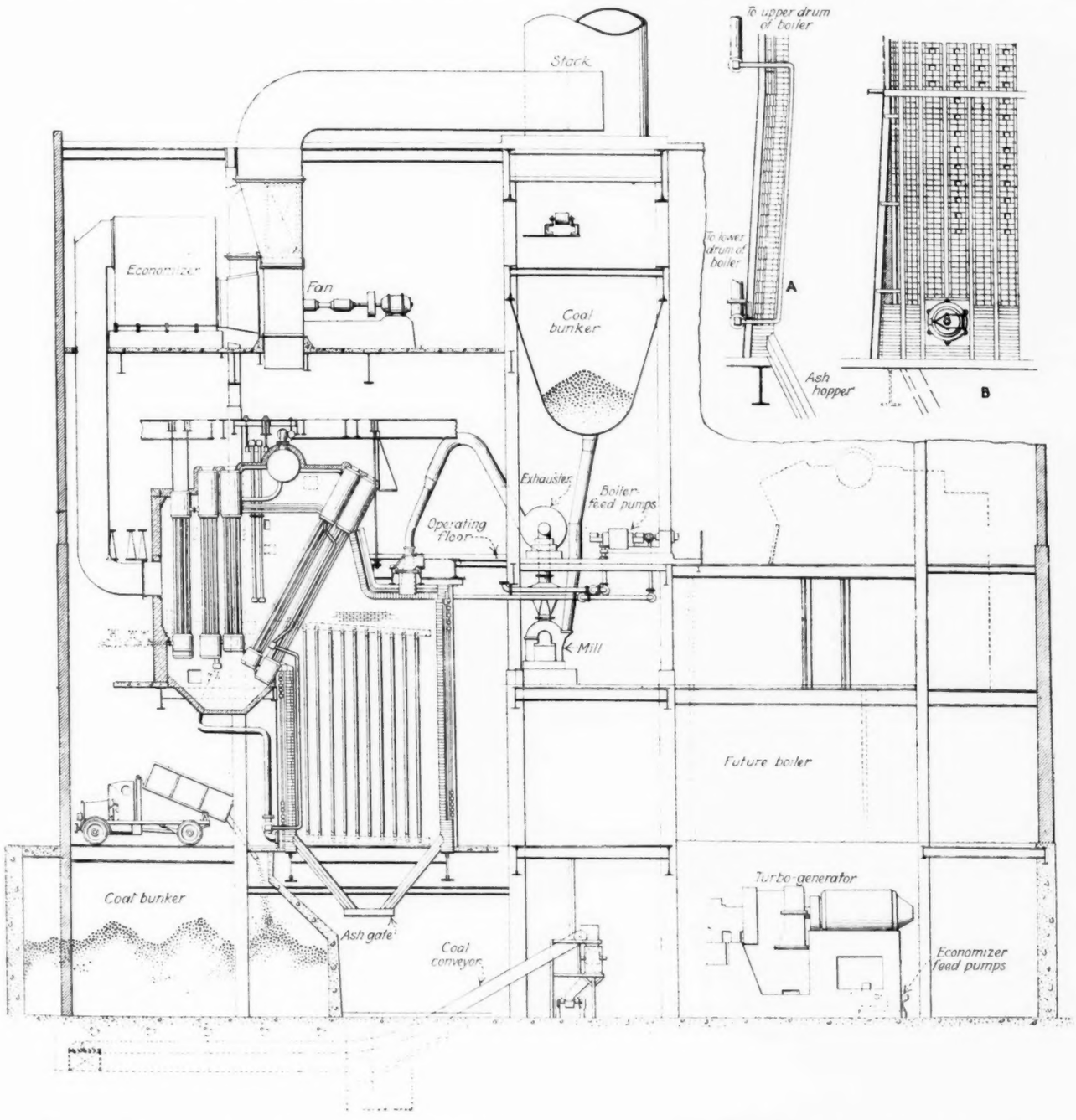


Fig. 1—Cross-section of plant showing compactness of layout, coal delivery and section through furnace

A—Furnace side walls are corbeled in and protected by water tubes. *B*—Secondary air enters furnace through openings in front walls.

and the vertically inclined portion is flexibly suspended by rods so that this slab can swing in or out or rotate around the suspension, to take care of the expansion or contraction of the arch itself or of the boiler. No packing is required between this arch and the boiler drums, as the motion referred to keeps the vertical arch always in contact with the boiler drums or the horizontal portion of the arch.

As indicated in Fig. 1B, secondary air openings are provided in the upper half of the front wall between each pair of 6-in. I-beams, the space between these I-beams being blocked off at mid-height. The secondary air for combustion is taken in at the bottom of the side walls, passes up through the space between the 6-in. I-beams to an air duct not shown on the drawing, which conveys the air to a duct along the front wall.

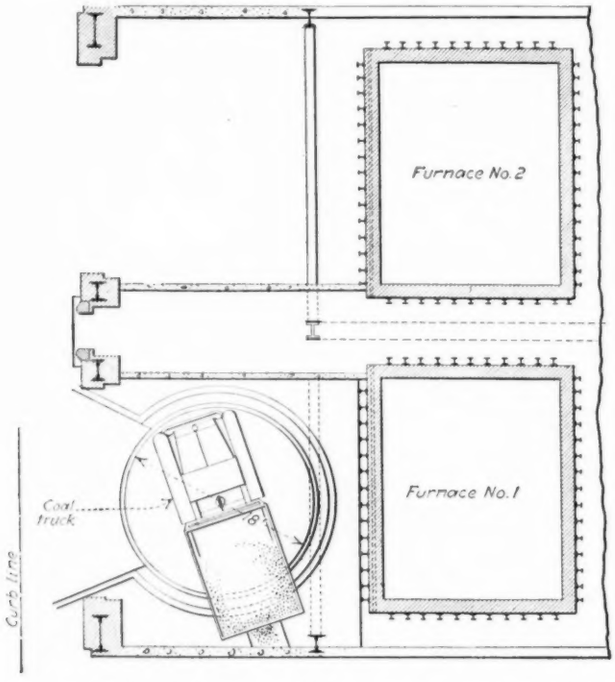


Fig. 2—The truck turntable facilitates receipt of coal

Damper control is provided in this duct across the front of the furnace so that the air entering the space between the 6-in. I-beam and the front wall can be controlled.

In addition to the duct taking air to the front, a duct is provided connecting the high portion of the side wall with a duct that supplies preheated secondary air to these burners, likewise under damper control.

Secondary air openings are also provided in six of the spaces between the 6-in. I-beams in the lower portion of the front wall. The air for these will be taken in at the bottom of the front wall, dampers being provided in each vertical duct between the I-beams. The remaining eight vertical ducts between the I-beams in the lower portion of the front wall are connected to a common air duct from which preheated air is delivered to the pulverizing mills. It is believed that supplying the mills with this preheated air will make it possible to handle very wet coal without material difficulty.

Water screen tubes are provided on the side walls and rear wall of the furnace. The side-wall tubes are spaced on 18½-in. centers and are connected to headers at the bottom and top of the furnace. In the case of the rear wall tubes it was felt that the ordinary tile baffles between boiler units might cause excessive building up of ash, and therefore these tile baffles were replaced by an additional 3½-in. tube, coming out of the upper B unit of the boiler and brought down midway between the outermost tubes of the A units. This tube from the top of the boiler runs into a connection box just above the bridge wall, and from this connection box a second tube runs to the lower portion of the rear wall, where it is brought out to a header.

The gases from the induced-draft fans pass through the roof to a flue which delivers them to a stack carried by the steelwork of the building immediately above the center of the bunker. The stack is 170 ft. high by 9 ft. in diameter, of reinforced concrete.

Coal will all be trucked into this plant. To facilitate handling the trucks, turntables are provided, one of which is shown in Figs. 1 and 2. A truck will be driven on the turntable, turned to the correct position for dumping, and after dumping, turned so that it can be driven head on out of the building. These turntables are directly above the basement coal bunkers.

As indicated in Fig. 1, coal is delivered by chutes to an apron conveyor which delivers it over a magnetic separator to a bucket conveyor by which it is lifted to the coal bunkers at the top of the building. The conveyors are motor driven with interlocks so that the apron conveyor cannot be started unless the bucket conveyor is in operation; and also so that a stoppage of the magnetic separator or the bucket conveyor will stop the apron conveyor. From the bunkers, coal flows by gravity through chutes to feeders which deliver it to the pulverizing mills.

A large tank in the basement receives the condensation returns from the heating system and receives the makeup water. Centrifugal pumps deliver this water to the economizers, and boiler-feed pumps take the water from the economizers and deliver it to the boilers. Two economizer feed pumps and two boiler feed pumps are installed initially. One of each is driven by a motor, the other by a turbine.

Operating Features

The plant is laid out for minimum operating labor, one man and a helper per shift. All the operating equipment is located on a single operating floor in the space between the main columns carrying the overhead bunkers. On this floor will be located the variable-speed motor-driven exhausters for the large pulverizing mills, the coal feeders for all the mills, the boiler-feed pumps, the control for the induced-draft fans, and the necessary switchboard and instrument panels for the operation of each individual boiler and its equipment. Control panels for the two boilers now being installed, and the future third boiler are grouped so that one operator can easily handle all the equipment. The control panels will include the usual pressure instruments, draft gages, meters, CO_2 recorders, etc.

A 3,000-kw. non-condensing turbine will be installed initially. This turbine takes steam at 375 lb. pressure and exhausts at such pressure between 5 lb. and 15 lb. gage as may be required to deliver the required steam through the low-pressure distribution system to heating customers. A special back-pressure control is provided, which can be set to maintain any desired back pressure and will automatically increase or decrease the amount of steam taken by the turbine as the back pressure may decrease or increase.

The generator is a 4,150-volt alternating-current machine delivering current directly to a 4,150-volt distribution system and, as previously indicated, the load carried by this generator is controlled by the demand for steam so as to maintain a given back pressure.

This turbine is designed to operate automatically without constant supervision. Automatic devices are installed so that in case the lubricating oil reaches too high a temperature or the oil pump fails to deliver oil, or the generator overheats, or the machine is thrown out of balance and vibrates, the unit will be automatically shut down and disconnected from the bus. In this event, reducing valves are provided to supply steam to the low-pressure distribution system.

The exhaust from the turbine, before passing to the low-pressure steam distribution system, passes through a coil reheater designed to give the exhaust steam from 20 to 40 deg. superheat. High-pressure live steam is used for supplying this heat.

By delivering superheated steam to the low-pressure distribution system, the condensation losses will be materially less than would be the case if saturated steam were used.

Motor and Substation Equipment

Special precautions have been taken in the selection of the motors used throughout the plant to provide sturdy equipment, capable of withstanding severe service. No-voltage release coils have been omitted on all essential motors so that after a momentary interruption these motors will start again automatically. In the case of slip-ring motors, the slip rings and brushes are inclosed in dustproof cases.

A portion of the space within the building is devoted to substation equipment, including distribution transformers, switchboards, etc. Five galleries are provided on the west side of the bay in which the turbine is installed. The distribution transformers are in fireproof compartments in the basement and are connected to the 220-volt secondary distribution bus. All the motors in the plant, as well as the outgoing secondary distribution lines, are connected to this bus, which can be sectionalized. By thus combining the station auxiliary load with the distribution system load, it is possible to use larger transformers than either load alone would warrant, and to reduce spare transformer capacity without reduction of reliability. Two 1,500-kw. three-phase units are being installed initially. While this plan has resulted in higher cost for the motor equipment, it effects considerable saving in the investment required to handle the secondary distribution system load supplied by this station, and gives a better load factor on the transformers.

The general features of design and construction have been under the general supervision of the writer, W. S. Burch, engineer in charge of the engineering department, Howard Harding, mechanical engineer, and I. E. Powell, superintendent of steam and hydrogeneration. D. L. Alloway is superintendent of the plant.

PRINCIPAL MECHANICAL EQUIPMENT FOR THE LAWN STREET HEATING

BOILERS

Make	The Bigelow Company
Type	Vertical Water Tube
Number installed	Two
Boiler pressure, gage, lb.	375
Steam temperature, deg. F.	540
Water-heating surface, sq.ft.	11,219
Drum	Dia. 48 in., plate thickness 1 3/32 in.
Tubes, diameter, in.	3¼

SUPERHEATERS

Make	Power Specialty Co.

ECONOMIZERS

Make	The Green Fuel Economizer Co.
Heating surface, sq.ft.	4,707
Ratio economizer area to boiler-heating surface	1 to 2.362

SOOT BLOWERS

14 for boilers	Diamond Power Specialty Co.

REHEATER

Make	The Superheater Co.

FURNACES

Type boiler setting	Brick steel construction
	DeWolf arch construction
Suspended arches	DeWolf arch construction
Arch brick	Harbison-Walker Refractories Co.
Furnace casing, transite	Johns-Manville Co.
Furnace volume, cu.ft.	10,000=1 cu.ft. per 1.12 sq.ft. of water-heating surface

BURNING EQUIPMENT

Pulverized-fuel system	Combustion Engineering Corp.
Number of mills	3 for boiler
Mills unit type	2,000 lb. per hour (1 mill)
	7,000 lb. per hour (2 mills)
Burners	Combustion Engineering Corp.
Burners per boiler	Five

DRAFT EQUIPMENT

Exhauster, mill	Combustion Engineering Corp.
Induced-draft fans	The Green Fuel Economizer Co.
Drive motor	Westinghouse Elec. & Mfg. Co.

STACK

Type	Concrete, brick-lined
Make	Rust Engineering Co.
Height above ground level, ft.	250
Height above operating floor, ft.	217
Diameter of stack, ft	9
Smoke flues, steel	Connery & Co.

COAL-HANDLING EQUIPMENT

Turntable	The Easton Car & Const. Co.
Apron conveyor	The Erskine-Healy, Inc.
	Jeffreys Mfg. Co.
Bucket conveyor	Jeffreys Mfg. Co.
Coal bunkers	Allen-Sherman-Hoff Co.

FEED PUMPS

High pressure	
1—6 stage pump (300 gal. per min.)	Pennsylvania Pump Co.
1—5 stage pump (500 gal. per min.)	Pennsylvania Pump Co.
Turbine	Terry Turbine Co.
Motor	Westinghouse Elec. & Mfg. Co.
Medium pressure	
2 pumps	The Goulds Mfg. Co.
Turbine	Terry Steam Turbine Co.
Motor	Westinghouse Elec. & Mfg. Co.

VALVES AND PIPING

High pressure	
Steel gate valves	Chapman Valve Mfg. Co.
Steel globe valves	Edward Valve & Mfg. Co.
Check valves	Chapman Valve Mfg. Co.
Boiler stop valves	Elliott Co.
Reducing valves	Ruggles Klingemann Co.
Atmospheric relief valve	Cochrane Corporation
Safety valves	Consolidated Valve
Blow-off valves	Yarway
Blow-off valves	Everlasting Rack & Pinion
Steam traps	Cochrane Corp.
Piping	W. M. Kellogg Co.
Steam header	Pittsburgh Valve Foundry & Const. Co.
Low Pressure	
Globe valves	Edward Valve & Mfg. Co.
Gate valves	Pittsburgh Valve Fdry. & Const. Co.
Piping	Pittsburgh Valve Fdry. & Const. Co.
Piping pulverized fuel	Pittsburgh Valve Fdry. & Const. Co.
Float valves	Klipfel Mfg. Co.
Blowoff piping	Pittsburgh Valve Fdry. & Const. Co.

TURBO-GENERATOR

Turbo-generator unit	General Electric Co.
Capacity, kw.	3,000
Voltage	4,150
Pressure at throttle, lb.	350 per sq.in. gage
Pressure at exhaust, lb.	5 to 20 per sq.in. gage
Air cooler	General Electric Co.
Atmospheric exhaust piping	American Spiral Pipe Works

MISCELLANEOUS

Crane—15 tons capacity	The Whiting Co.
Feed-water regulators (Copes)	Northern Equipment Co.
Metering equipment	The Bailey Meter Co.
Machinery foundations	Cork Foundation Co.
Return-water storage tank	Hammond Iron Works
Air compressor	Ingersoll-Rand Co.
Economizer tanks	Coatesville Boiler Works
Magnetic clutches	Cutler-Hammer Mfg. Co.

Instruments in the Private Power Plant

THIRTY years ago the pressure gage, in its various forms, was practically the only power-plant instrument in common use. Whether applied to boiler, engine, compressor, furnace (draft gage) or condenser (manometer indicating vacuum), it was of the indicating type only. Polishing the brass cases of these gages was one of the principal indoor sports of the old-time engineer.

How different is the well-equipped plant of today with its steam-flow meters, feed-water meters, recording pressure gages and thermometers, coal weighers, CO_2 recorders, liquid-level indicators, speed indicators, etc.! The following classification indicates some of the principal uses to which instruments are put in modern industrial plants.

INTRUMENTS CLASSIFIED BY KIND OF QUANTITY MEASURED

Pressure:
- Steam—boiler, throttle, receiver, back pressure, condenser.
- Water—city supply, plant service, boiler feed.
- Air—suction, receiver and discharge of compressors.
- Furnace air and gases—draft suction, draft pressure, draft drop.
- Atmosphere (barometer).

Temperature:
- Air—outdoor, room, compressor receiver and discharge, inlet and outlet of indirect heating coils.
- Flue gas—boiler passes, uptake, economizer outlet.
- Steam—superheater outlet, engine throttle.
- Water—city supply, hotwell, heater outlet, economizer inlet, boiler feed, boiler blowdown, hot water for service and building heating, condenser circulating inlet and discharge.
- Bearings—engines, turbines.
- Fuel oil—to heaters, to burners.
- Lubricating oil—to bearings, to and from coolers.

Volumes and weights by flow meters:
- Air and gas—compressor discharge, fan discharge, furnace air and gases.
- Steam—leaving boiler, to engines or turbines, to process, to heating, to auxiliaries.
- Combined air and steam flow (for combustion control).
- Water—makeup, feed, circulating, cooling.

Volumes and weights by weighing or displacement meters:
- Water—makeup, feed, cooling.
- Fuel oil—to burners.
- Coal—to storage, to bunkers, to boilers.

Flue-gas composition:
- CO_2 alone.
- CO_2 and combustible gases.

Speed (engines, turbines, pumps, stokers, compressors).

Humidity (ventilating air).

Specific gravity (fuel oil).

Liquid level (oil tanks, water storage, boiler drums).

This classification could be expanded considerably without listing the various types of instruments used for each kind of measurement. Many such types are available. There are innumerable ways of measuring pressure and temperature, for example; moreover, the instruments for these measurements may indicate only, indicate and record on charts, or simultaneously indicate, record and integrate the total.

Flow meters may use an orifice, a pitot tube or a venturi tube in the meter body, while the resulting pressure differences which measure the flow may be translated into flow readings in a variety of ways, mechanical and electrical. Flow meters, like the pressure and temperature instruments, may merely indicate, or indicate and record, or indicate, record and integrate. Wherever a record of varying conditions is of sufficient value in checking up on the personnel, condition of the equipment or method of operation, the recording type of instrument is coming more and more into favor.

The question of purchasing an instrument for any particular purpose should logically be based on a reasonable estimate of the probable savings. For example, the coal loss likely to result from operating boilers without constant knowledge of actual combustion conditions is, in almost every case, large enough to justify a considerable expenditure for combustion control instruments. On the other hand, a recording thermometer on an engine bearing might be an unwarranted refinement in a small plant. In every case common sense and engineering analysis should determine the purchase of instruments.

The accompanying photographs were taken in industrial plants well equipped with instruments. A power plant unusually well provided for in this respect is that of the Whitin Machine Co., Whitinsville, Mass. The heavy power and heating load at this plant has justified an extensive installation of instruments, some of which are pictured in Figs. 1 and 2.

Fig. 1 shows a feed-water recording thermometer (left) in the boiler room. On the right are two steam-flow, air-flow, flue-temperature instruments used as a guide in maintaining combustion efficiency. All the completed instrument charts in this plant are stored on pegs in a centrally located cabinet with glass doors (Fig. 2). At the right are three electrically operated flow meters measuring steam supplied to the turbine and two high-pressure process lines.

A control board for the shop hot-water system carries eight instruments measuring pressures and temperatures. One of the temperature recorders has its bulb in the shop 500 ft. away. Another board in the Whitin plant carries fourteen different instruments, recording or indicating all important pressures and temperatures in the feed-water steam circuit.

Fig. 3 shows an installation of CO_2 recorders over the watch engineer's desk in the new Equitable Building, opposite the Pennsylvania Station, New York City.

The electrically operated flow meters shown in Fig. 4, indicate, record and integrate the steam and air distributed to near-by textile mills from the co-operative power plant at Reading, Pa. Accurate measurement is here essential as a basis of charging for the steam and air supplied.

Fig. 1 (Below)—Recording feed thermometer (left) and two steam-flow, air-flow, flue-temperature instruments in boiler room of the Whitin Machine Co., Whitinsville, Mass.

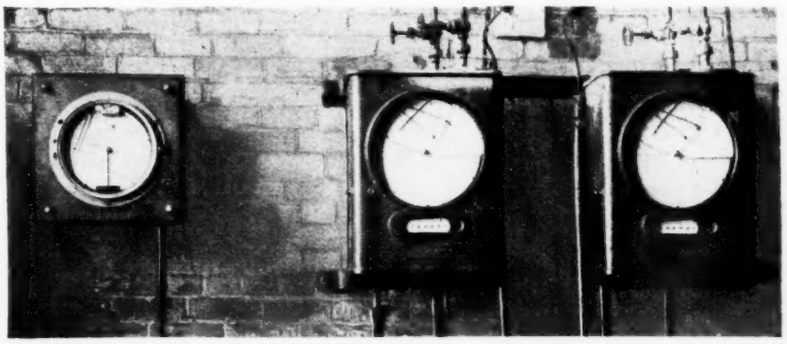


Fig. 3 (Above)—Watch engineer keeps an eye on combustion from his desk in the power plant of the new Equitable Building (New York City)

Fig. 2 (Below)—Another view in the Whitin Machine Co. power plant, showing chart case and three electrically operated steam-flow meters

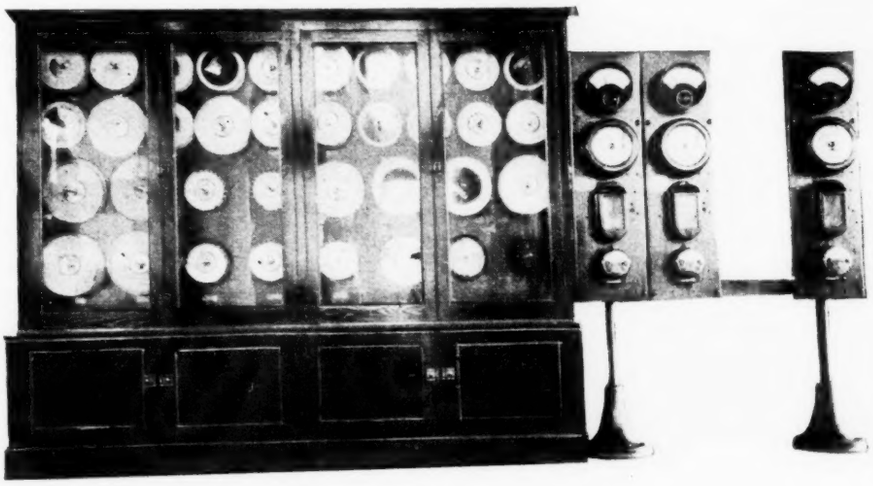
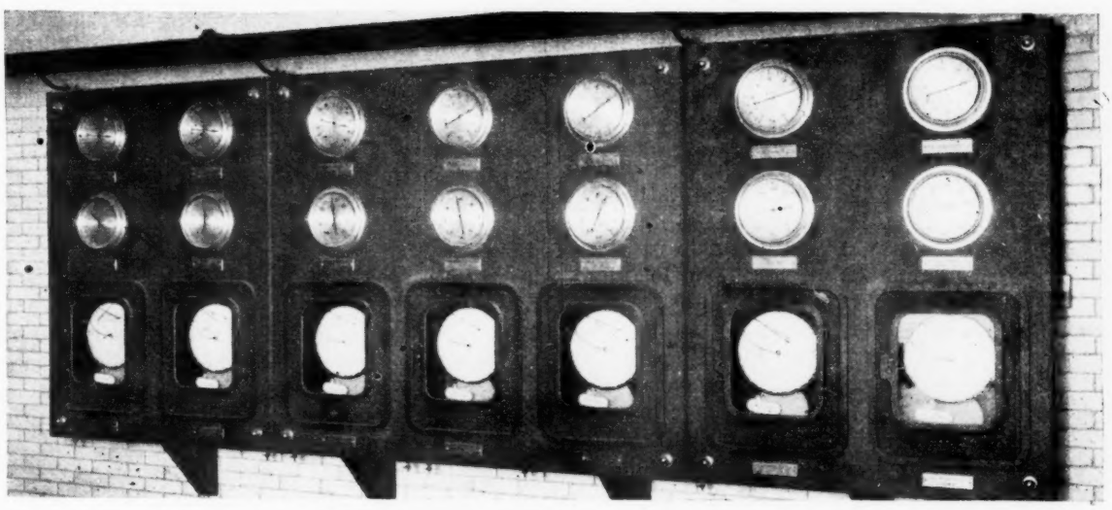


Fig. 4 (Below)—Group of seven electrically operated flow meters measure distribution of steam and air from the co-operative power plant at Reading, Pa.



The Steam Engine Still in Favor in the Isolated Plant

Kinds of Service to Which the Steam Engine Is Especially Adapted and Factors That Are Reacting in Its Favor

THE thermal efficiency of the condensing reciprocating steam engine may not equal that of the turbine or oil engine, but, as a non-condensing machine, its adaptability to operation against a back pressure makes it most suitable for installation where the amount of process steam is less than the prime mover consumption.

At present many unaflow engines are being installed to operate against a variable back pressure, clearance pockets or auxiliary exhaust valves being provided to permit the engine to maintain its final compression pressure regardless of the exhaust-pressure conditions. The use of stage or receiver bleeding is again becoming the practice, the high-pressure cylinder being a unaflow while a Corliss valve gear is fitted to the low-pressure cylinder. Such an installation, using steam at 200 to 300 lb. pressure, permits steam at 50 to 100 lb. to be drawn from the receiver, while the low-pressure exhaust is also sent to the process machines at any desired pressure. Since the poppet-valve gear can operate under high pressures, the plan of inserting an engine between the high-pressure boiler and the process system gives power at a very low cost.

Condensing operation in summer with a heating-system back pressure in the winter is a plan worthy of study. If the engine is of an efficient type, even non-condensing operation in summer may be economically possible, and many new plants are so operated.

Meeting Space Limitations

The problem of installing engines in office-building basements is often perplexing, inasmuch as floor space is highly valuable in the larger cities. This difficulty confronted the owners of the Kern Building in New York City. The original installation consisted of two 75-kw. and one 150-kw. 250-volt direct-current generators direct connected to unaflow engines. When the load increased, the impossibility of getting a 350-kw. horizontal unit within the existing space was recognized and the 4-cylinder 500-hp. vertical unaflow shown in Fig. 4 was purchased.

This machine has cylinders 13-in. bore by 14-in. stroke and turns at 300 r.p.m. This plant, containing, besides the four unaflow units, two ammonia compressors and three 3,150-sq.ft. water-tube boilers, is interesting in view of the services rendered. The building is devoted to printing and allied trades. In addition to power for the presses and elevators, in winter heating is supplied by the power plant. Next door is a meat-products house that requires large quantities of steam for cooking, as well as refrigeration for the storage rooms. The load is well balanced both summer and winter, and energy is produced at a cost of under 1.5c. per kilowatt-hour.

In Fig. 2 are shown the three 400-kw. unaflow engines installed in a glass factory at New Kensington, Pa. The plant delivers energy at a cost somewhat under the central-station charge.

In Fig. 3 is shown one of the two 250-kw. unaflow engine-generator sets installed in the plant of H. C. Godman Co., shoe manufacturers, Columbus, Ohio. The contract price for the units was $29,500, of which $12,000 was paid on installation. The balance was paid out of the earnings based on a comparison with purchased current at 1.55c. per kw.-hr. The estimated annual saving was $9,600, but it has developed after operation began that the saving actually made is around $14,000 a year. During June of this year 90,000 kw.-hr. were generated from 232.5 tons of coal. The factory used 873,800 lb. of live steam in process work, or approximately 20 per cent of the steam generated. Inasmuch as no exhaust steam was used for heating, etc., the engines were not credited with the value of the exhaust steam. During winter months, with proper crediting of the exhaust used for heating, the power costs are much less than during the summer months.

Where Variable Speed Counts

Certain services require that the prime-mover speed be capable of a wide adjustment. This makes electric drive inadvisable, and the steam engine is practically the only type that will successfully function. In Fig. 1 is shown one of the two unaflow engines in a gas-pumping station of the Kings County Gas Co., New York. Gas is made in a central plant and is pumped into holders at substations. Each engine in the substation drives a Root blower, taking gas from the holder and delivering it into the distribution mains at a constant pressure. If the line pressure increases, the engine is slowed down by the manipulation of a governor regulator, this being the disk on the end of the engine layshaft shown in Fig. 1.

While the poppet-valve engine is favored when high pressures and superheats are carried, many Corliss engines are being installed for low pressure or other special conditions. One recent contract called for a number of large Corliss engines for gas compressor operation where the speed had to be low, making the Corliss more efficient than any other type of steam engine.

Due to certain economic factors, such as coal prices, labor scarcity and difficulty of raising funds, there has been a drift toward the use of purchased current. Nevertheless it is possible to discern the beginning of a reaction toward a utilization of the steam engine or steam turbine exhausting at a high pressure into the factory lines, where the present practice is to use live steam for process work. This often includes the employment of boiler pressures of from 300 to 400 lb. and compound engines or turbines exhausting at as high as 100 lb. back pressure. The fuel cost for power so developed is surprisingly low.

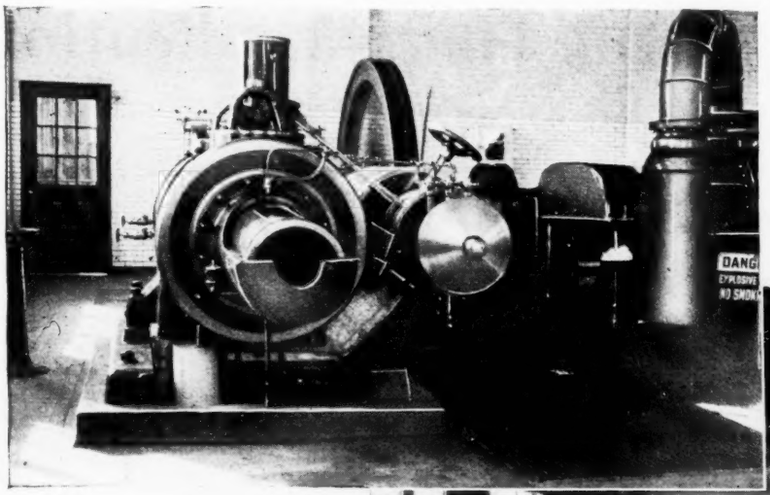


Fig. 2 (Below) — Three 400-kw. unaflow engines supply power to a Pennsylvania glass factory

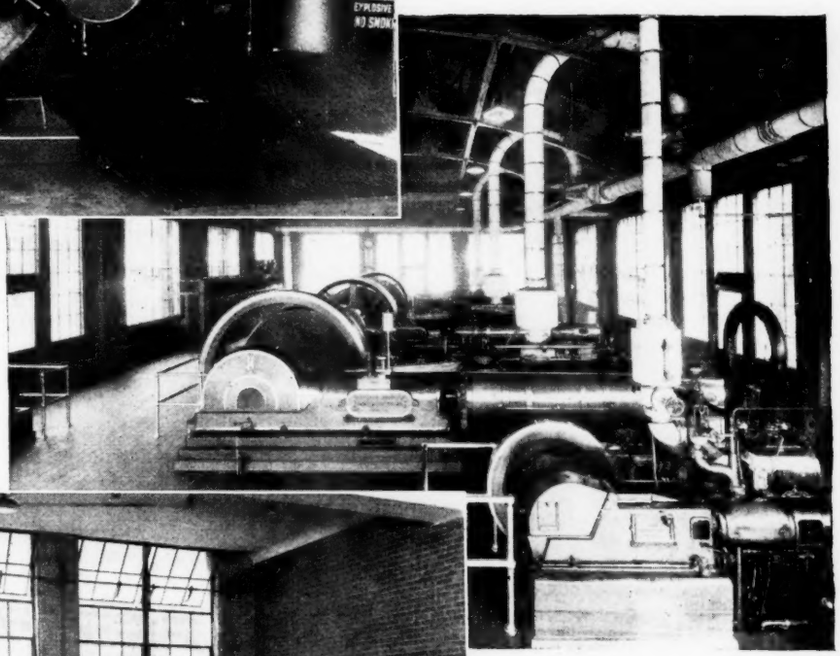


Fig. 1 (Above) — Unaflow engine drives blower in the substation of Kings County, N. Y., artificial gas system

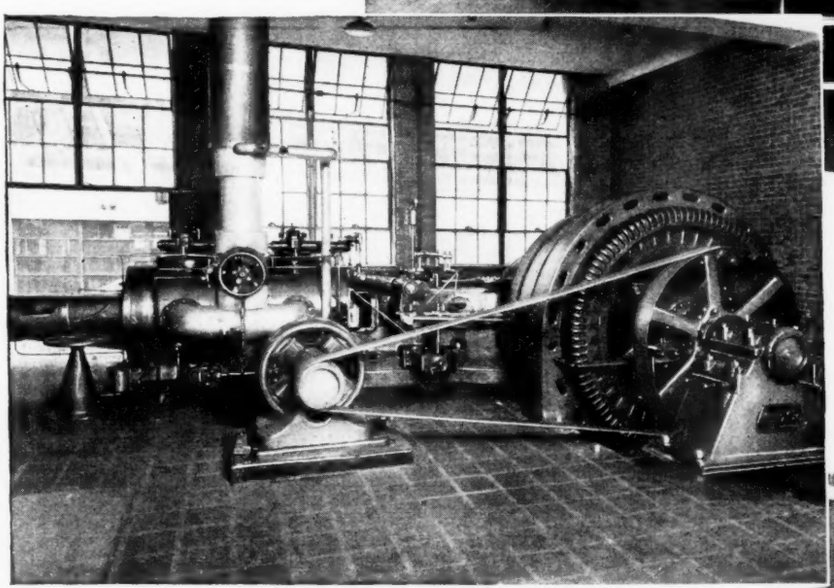


Fig. 3 (Left)—One of two 250-kw. engines in the shoe factory of H. C. Godman Co., Columbus, Ohio. The plant is being paid for out of earnings

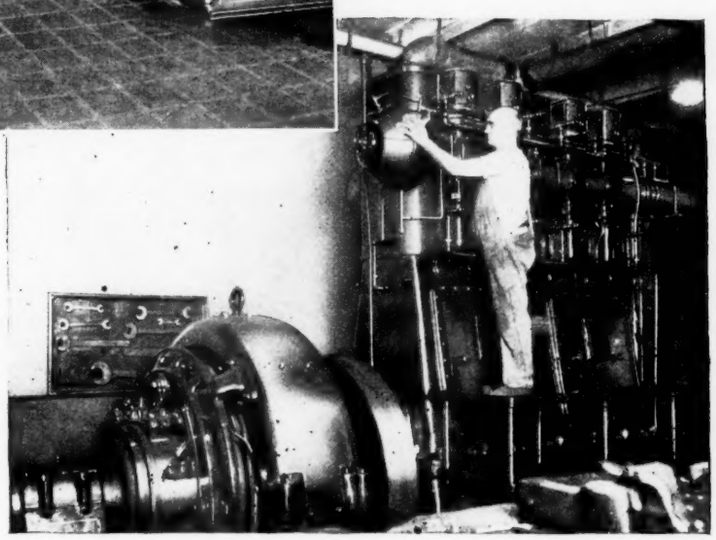


Fig. 4 (Right)—This 500-hp. vertical engine was installed in an office building when space did not permit the use of a horizontal unit

Electric Motors and Their Application

WITH direct-current, motor applications are limited to a comparatively few general types, although the characteristics of these types may vary widely to suit those of the load they are driving. These motors may be divided into three classes—shunt, series and compound. For general service the shunt motor is the prevailing type. It has practically a constant speed and is well suited to these types of drive. Where wide ranges of speed adjustment are desired, it will generally be found best to procure a motor designed for this class of service. Such motors usually have interpoles, and where they are applied to reversing service, they may also have a compensating winding in the pole faces. However, the general-purpose shunt motor will allow increasing its speed from 15 to 25 per cent by field control without distress, provided the motor has ample capacity to carry the load at the high speed. If a motor has been driving a load at normal speed and it is decided to increase the speed, careful consideration must be given to the characteristics of the load. The fact that a motor has 20 per cent reserve capacity, is no indication that the speed of the load can be increased that much without overloading the motor.

The torque of the shunt motor increases as the current in the armature. Where it is desired to have a motor that has a constant speed and a higher torque than a shunt motor, the compound type is used. This motor has, in addition to a shunt-field winding, a second winding on the field poles connected in series with the armature. Therefore as the current increases in the armature, the strength of the field poles is increased, with the result that the torque increases at a rate greater than the current in the armature. On account of the action of the series-field the speed of a compound motor is not as constant as a shunt, with the same load changes. This, in some classes of drives, is an advantage; for example, with fluctuating loads that have a heavy flywheel. It should be remembered that where a flywheel is to be used to absorb the peaks of a fluctuating load, the motor drive must have a drooping speed characteristic, as the flywheel cannot give up its energy unless the load slows down.

Series motors are sometimes applied to the driving of fans and pumps, but these are usually of small size. Their widest application is in crane and railway service.

Alternating-Current Motors

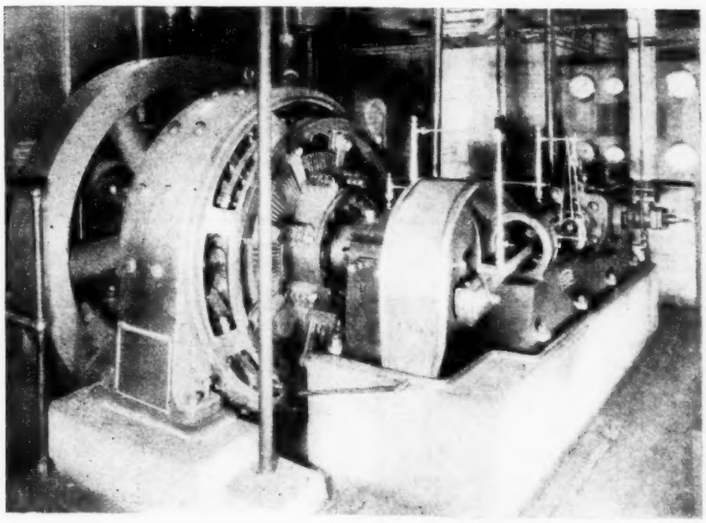
In the application of alternating-current motors, although the same general rules must be observed that apply to direct-current motors, there is a much wider range of motor types to choose from. Single-phase motors are in general used in very small sizes only and will not be given further consideration. Considering the polyphase motors alone, there are the squirrel-cage and wound-rotor types of induction motors, various types of synchronous motors, the synchronous-induction motor, the commutator-type variable-speed motor, the commutator-type adjustable-speed motor and the multi-speed squirrel-cage and wound-rotor types. There are also special schemes of speed control that require regulating sets, the interconnection of two or more motors and the use of frequency change sets. In addition to selecting a motor that has the correct characteristics for the drive proposed, the effects that the motor will have on the power factor of the system should be given careful consideration.

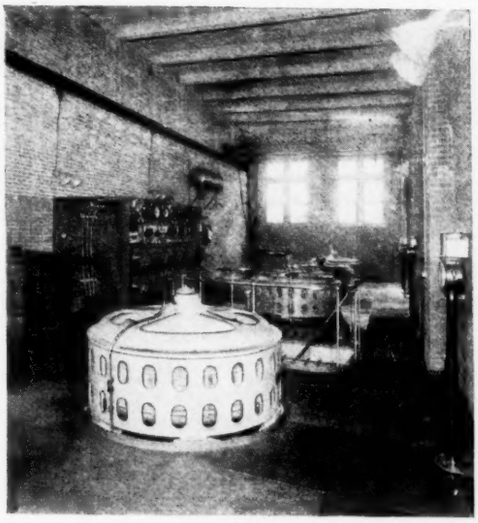
For general purpose motors the squirrel-cage and wound-rotor are the prevailing types. The squirrel-cage motor is simple and substantial in its construction and operation, but is inherently a constant-speed machine. The wound-rotor motor has an insulated winding on its rotor, connected through slip rings and bushes to an external resistance, which is cut out as the motor comes up to speed. This arrangement gives a higher starting torque, allows a better control of the current during the starting period than can be obtained with a squirrel-cage type, and also provides a means for a certain amount of speed control, particularly on constant loads. The speed of the motor can be reduced about 50 per cent below normal by inserting external resistance in series with the rotor. The two most serious objections with this system of speed control is that the speed varies with the load with a given setting of the controller, and if the load is removed the speed will increase to near normal. Also at reduced speeds the efficiency is decreased. With constant torque loads this is the most serious, since at half speed the motor is taking the same power from the line as at full speed, but is developing only one-half the horsepower. With a fan or a centrifugal pump the load decreases rapidly as the speed is reduced, so that the losses in the external resistance will be only about 40 per cent of what they are for a constant torque load.

Methods of Speed Control

If satisfactory speed control cannot be obtained with a wound-rotor motor, then a multi-speed motor or some other type will have to be used. Multi-speed motors have their stators wound for two or more speeds; that is, the stator may be wound for 4 and 8 poles, which on a 60-cycle system would give approximately 1,800 and 900 r.p.m. respectively. By using a wound rotor with external resistance, speed ranges below these values may be obtained. Instead of using this arrangement, the commutator-type variable-speed or adjustable-speed motor may be used. Where a number of adjustable-speed motors are required, it may be found advisable to convert the alternating current into direct and use direct-current motors.

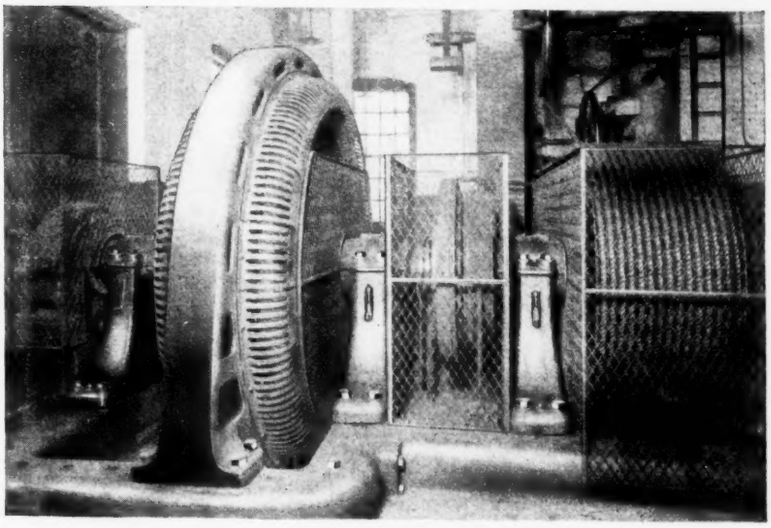
The power factor of the induction motor at best is seldom in excess of 90 per cent and at reduced load is much lower. A low power-factor load has many objectionable features and should be avoided where economically possible. This has brought the synchronous type of alternating-current motor into increasing favor. Not only can this motor be made to operate at unity power factor, but the power factor can be controlled. There are many classes of devices that are well suited to this type of motor, such as compressors, pumps, fans, jordans, ball-and-tube mills, etc., and improvements made in the motor's design are increasing its field of application. In many installations synchronous motors, or synchronous-induction motors, can be used in combination with induction motors to good advantage.



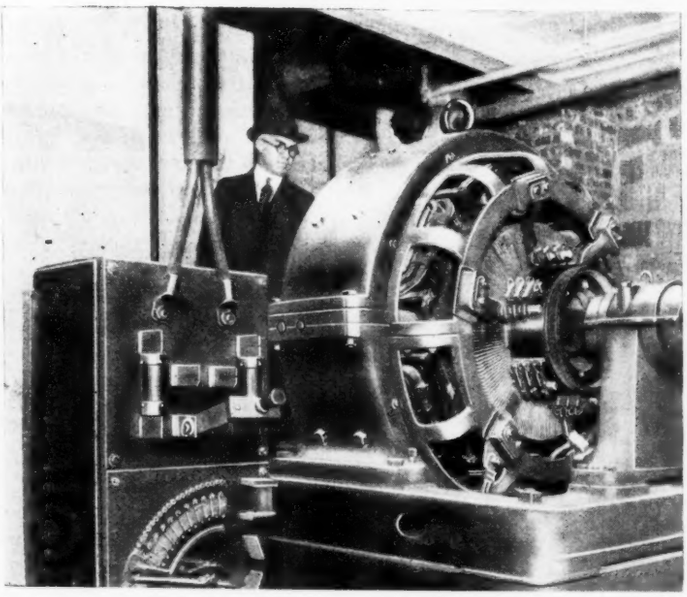


Above — Direct - current motor mounted directly on the shaft of a duplex ammonia compressor

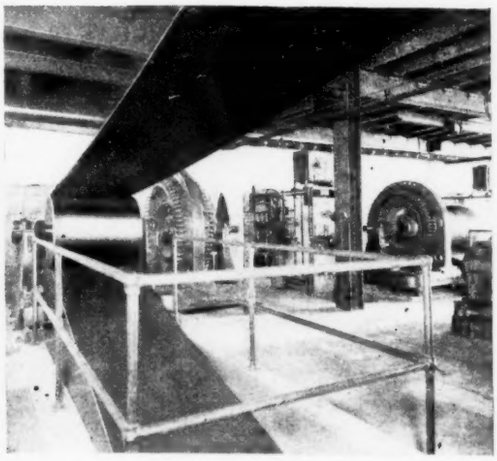
Above, Right—Four automatically controlled, vertical-shaft induction motors directly connected to centrifugal pumps



Above—Synchronous motor, rated at 650 hp., connected to its load through a rope drive



Adjustable-speed direct-current motor, rated at 110 hp., directly connected to a ventilating fan



Synchronous motor, rated at 500 hp., belted to ammonia compressor

Engineers of Industrial Plants Should Understand Refrigeration

IN ALMOST all lines of industry refrigeration is used. Power-plant engineers must understand how the system works and be able to make adjustments.

THE refrigerating machine is not an apparatus of concern solely to the iceman, but is an adjunct of the power department and is under the care of the operating engineer. Although the ice industry is not expanding at any rapid rate, the number of refrigerating machines built yearly reaches into the thousands. The great mass of compressors, condensers, evaporating coils, etc., is found in industrial factories and mills, such as tool works, bread bakeries, hotels, office buildings, packing houses, etc.

In works making axes, chisels, saws, etc., it is necessary that the tools be heat-treated. While air hardening is still practiced by some, it has been found that immersion in oil gives the best results. The heat absorbed from the hot tools increases the temperature of the oil, and this heat must be later removed by some form of cooling. Water cooling has been practiced, but the tendency is toward the use of mechanical refrigeration for this purpose. Such an installation was made in Fayette R. Plumb's tool works in St. Louis, Mo.; this 6-ton machine is illustrated in Fig. 3. The double-pipe condenser is fastened to the wall, and the oil-cooling tank, which contains the evaporating coils, is under the floor. A centrifugal pump circulates the cooled oil to the several tempering tanks.

Refrigerating is a necessity in chocolate and candy factories in order that the materials be kept at the proper working temperature. In candy factories where chocolate coatings are placed on liquid or semi-liquid centers, it is necessary to chill the liquid until it is in a solid state, after which the chocolate coating is poured over it. The storage rooms are kept at a uniform temperature. In the making of the Eskimo pie, which consists of an ice-cream rectangle coated with chocolate, refrigeration is needed to chill the chocolate coating before the heat melts the ice-cream center.

The manufacture of bread in modern bakeries is far more complicated than the bread making practiced by the housewife. In the first place the water used to mix the dough must, for best results, be cooled to a definite temperature. In a bakery whose daily output runs into thousands upon thousands of loaves, the amount of water is enormous. After the dough is mixed, it must be stored long enough to permit it to rise. The yeast germ works more efficiently at a fairly low temperature. So anxious is the baker after the germ's welfare that the air in these rising rooms is kept at the cool temperature so appreciated by the yeast. During the mixing process, when the dough is dumped into machines that mechanically duplicate the hand-kneeding process of the old-time cook, the mass is kept cool by the use of refrigerating machines. Such a machine is shown in Fig. 2, being part of the power plant of the Nafzigee Baking Co., Kansas City, Mo.

Cooled drinking water was an unheard-of luxury in buildings of twenty years ago. Now it is seldom that a building is erected that does not contain a refrigerating plant for the chilling of the drinking water. These systems are usually of from ½ to 5 tons capacity, but embrace all the elements found in the largest refrigerating plant. The operation is frequently unsatisfactory for the reason that the engineer is not familiar with the peculiarities of the plant. While no startling power reduction is possible by keeping the refrigerating system in good shape, certainly the advantage of a reliable drinking-water system is enough to justify some attention.

It will be noticed that the smaller machines shown are motor driven, while those shown in Figs. 2 and 4 are steam driven. The steam cylinder in Fig. 2 is fitted with Corliss valve gears. This gear was almost exclusively used on steam-driven compressors up to four or five years ago. Since then the poppet valve gear, such as shown in Fig. 4, is being adopted by almost all the compressor builders, being able to handle high-pressure and high-temperature steam more successfully.

While many four-valve steam cylinders are still sold, the tendency is toward the general adoption of the unaflow principle. As long as distilled-water ice plants were used, the steam consumption of the prime mover was not of great importance, as the distilled water needed exceeded the exhaust steam from the engines. With the development of the raw-water system and the more general use of refrigeration in the industries the unaflow engine has been more and more used as the driving unit.

In the manufacture of ice the majority of new plants in the large cities have installed motor drive, inasmuch as the central stations have made rates practically equal to the cost of electrical production. In the smaller communities such plants are mainly driven by oil engines. On the other hand, in industrial plants the small units are belt driven from lineshafts or electric motors; while the larger units are steam driven.

Manufacturing processes in recent years have become so complicated and refined that temperature regulation has become imperative in the mass of industrial factories. Even if it be merely a case of providing cool air for conditioning work, some type of refrigeration is needed. In such widely different work as the manufacturing of high explosives used to kill mankind and the making of gum drops to feed him, somewhere in the process a refrigerating machine is relied upon to assist in the manufacture.

Refrigeration is a science with which the progressive engineer who intends to follow industrial power-plant engineering must become acquainted. The knowledge of the operation of the compressor and its drive, the condenser, the evaporator and incidental apparatus is just as vital to engineers as like information on his boiler, engine, condenser, etc.

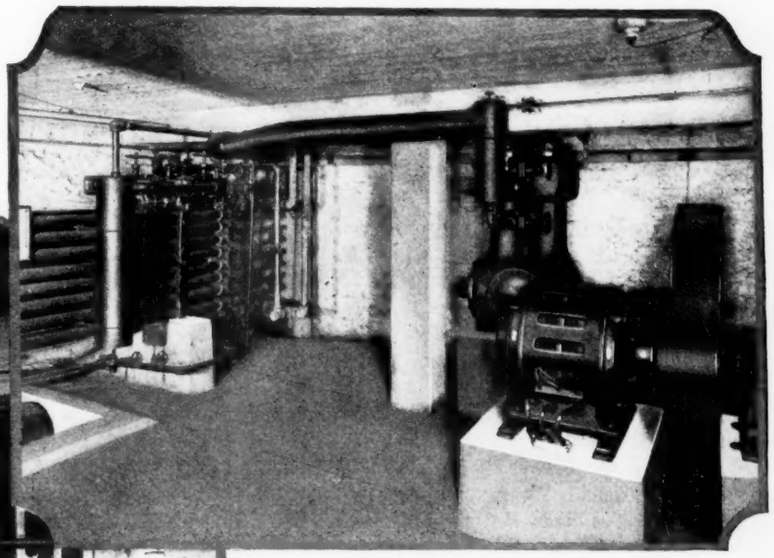


Fig. 2 (Below) — Refrigerating machine used in a chocolate factory

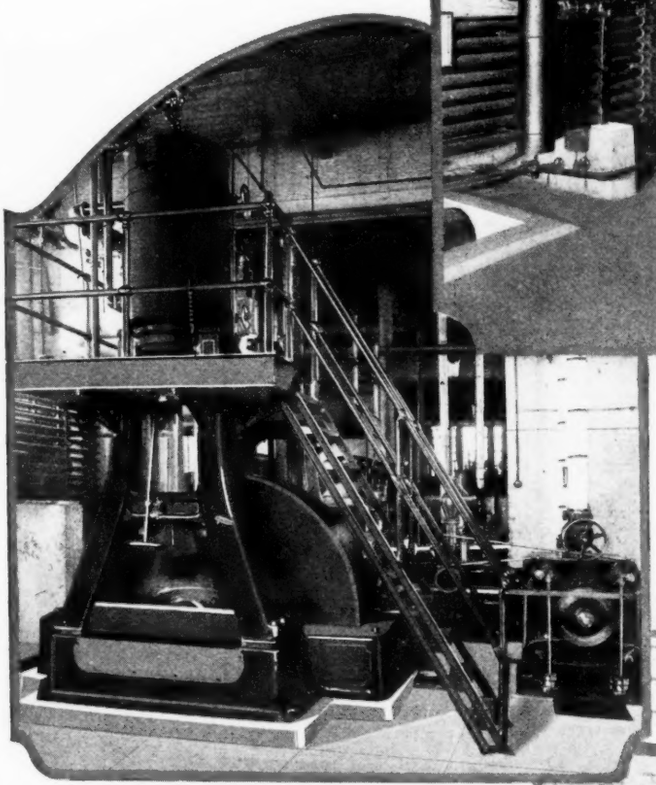


Fig. 1 (Above)—In bread making, refrigerating machines are needed to control the dough

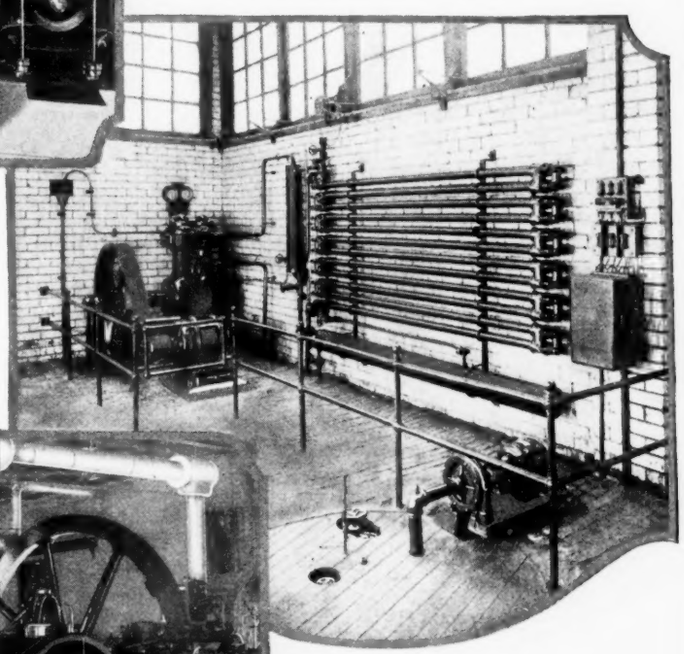


Fig. 3 (Right) — Heat-treating of tools requires oil which is cooled by refrigeration

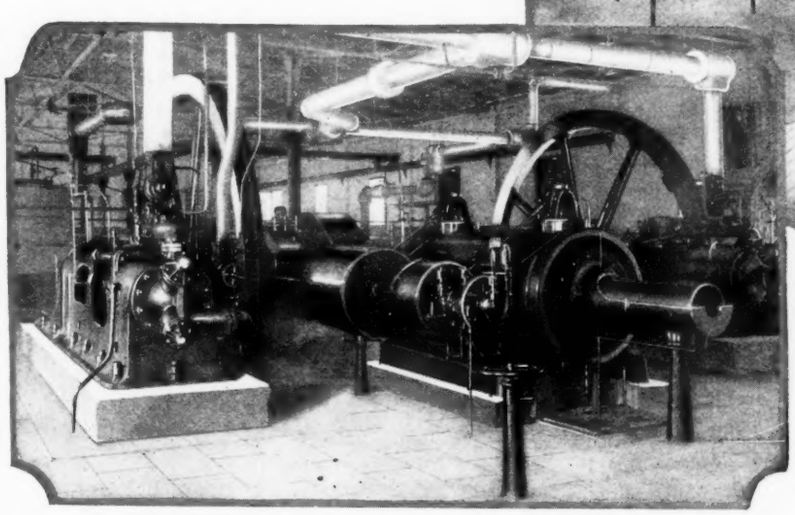


Fig. 4 (Left) — Refrigerating machine used in a tropical ice and cold-storage plant

Some Uses for Oil Engines

Suitability of Oil Engines for Plants Needing Process Hot Water—Comparative Operating Expenses and First Costs of Diesels and Steam Engines

IN SEEKING ways and means of reducing power costs, it is debatable whether the engineer gives the oil engine the consideration due it. In spite of the fact that approximately 120,000 hp. of these engines are yearly installed in essentially industrial plants, there is a general feeling that they are more suitable for central-station and oil-pipe-line work than for the furnishing of power to factories and mills.

The thermal efficiency of the oil engine is high, and it is generally conceded that the operating costs are below those of a steam plant of like capacity and even equal those of many large central stations. The objection chiefly raised is that the first cost is so high that a cheap type of prime mover is more advisable. This is especially true where the boilers of an existing plant are in good condition, only the engines needing replacement. The lower cost of steam engines has heretofore practically barred the use of the oil engine. Recent events point to the placement of the Diesel upon a more favorable footing.

Installation Costs

Reductions in prices have been sharp, and at present an oil-engine plant can be installed for much less than the cost of a complete modern steam plant. In many instances prices approach those of high-grade steam-engine sets. Overhead charges are consequently lower than formerly, making the total charges below the cost of other forms of power save in favored localities.

Many mills are in a position where they are unwilling or unable to raise the cash needed for the purchase. To overcome this difficulty, there is a marked tendency among engine builders to sell on the deferred payment plan. This calls for about 25 per cent cash payment, with the balance taken care of by the savings made in the power costs. In fact a guaranteed saving plan is offered by some firms, which in effect insures the purchaser that the savings will pay the installation costs within a stated period.

Meeting Process Steam Requirements

A current assumption in engineering circles is that where process steam or hot water is needed, a steam plant becomes imperative. Central stations exposed the error by successfully electrifying mills, the boilers supplying the process steam directly. The oil engine, producing power at a low cost, has the advantage of being able to supply hot water or steam from the cylinder jacket and exhaust line. Such arrangements have been successfully made in many mills, and while it is often necessary to keep one or more boilers in operation, the total power and process-steam costs may be substantially less than under former conditions.

In Fig. 1 is shown a 450-hp. solid-injection oil engine installed in the Thos. Oakes woolen mill, Bloomfield, N. J. A 100-hp. engine running at 200 r.p.m. was installed in this plant in 1913, and its success prompted the purchase in 1916 of the 450-hp. unit. These engines have a capacity factor of from 90 to 100 per cent, consequently the overhead charges per horsepower output are low.

Recovery of Waste Heat

The exhaust pipes are jacketed and the warm water from the cylinder jackets are further heated by the exhaust gases to have a temperature of 130 deg. F. when the water reaches the dyehouse.

The subject of waste-heat recovery systems is one not given proper attention. In every plant use can be made of hot water or low-pressure steam ordinarily produced at the expense of fuel. Approximately 2,500 B.t.u. can be recovered from the engine cooling system for each horsepower-hour developed. This, in terms of hot water, represents over 30 lb. of water raised from 60 to 130 deg. F., which in a 500-hp. plant means 15,000 lb. an hour. By sending this water through an exhaust heater, the temperature can be raised to 212 deg. F. without trouble. The investment in the heater or boiler is justified by the savings made.

Flour mills require an uninterrupted power supply, inasmuch as at each stoppage the rolls and chutes must be cleared before restarting. Inasmuch as power represents the major manufacturing cost, it is essential that the operating expenses of the prime movers be low. Both of these are possible in Diesel-powered mills, and as a consequence the tendency is away from steam to oil-engine power, units of from 25 to 1,500 hp. being installed. Power costs, when a well-designed oil engine is installed, range from 6 to 12c. a barrel of flour, the overhead charges adding a few cents more.

Diesels in Cement Mills

Cement, like flour, is a product whose major manufacturing costs are made up of power and fuel. Even in localities where coal is available at low prices, the cement industry has not hesitated to install oil engines. In the Western mills the Diesel predominates, plants of as high as 5,000-hp. capacity being in operation. In Fig. 4 are shown three 800-hp. units installed in the Gerlach, Nev., mill of the Pacific Portland Cement Co. One engineer and one oiler make up the engine-room force on each shift, and over 10 kw.-hr. are produced per gallon of oil. The power house is at some distance from the cement mill, consequently the dust in the air is not a problem.

An unusual installation is illustrated in Fig. 2. These two engines are installed in the power plant of a Missouri iron mine. Power is supplied to run the compressors, concentrating mill, etc., used in and around the mine.

Packing houses are users of large quantities of hot water for cooking purposes. Nevertheless, engines have been installed with satisfactory operating results. The 120-hp. engine supplying power to the Emge Packing Co., Fort Branch, Ind., is illustrated in Fig. 4.

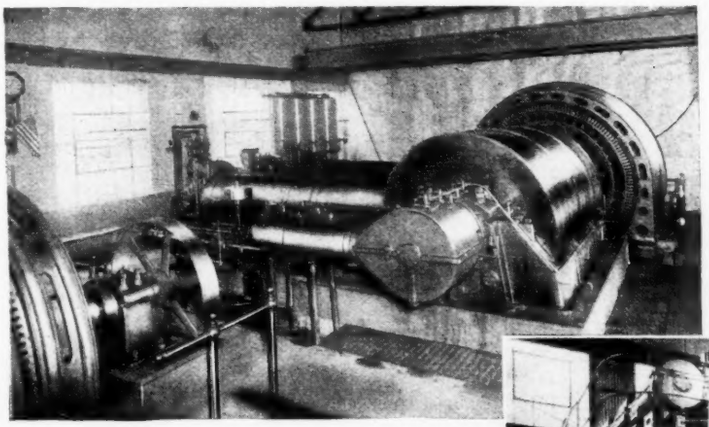


Fig. 1 (Left)—Woolen mill uses this 450-hp. solid-injection oil engine. Jacket water goes to dyehouse for process requirements

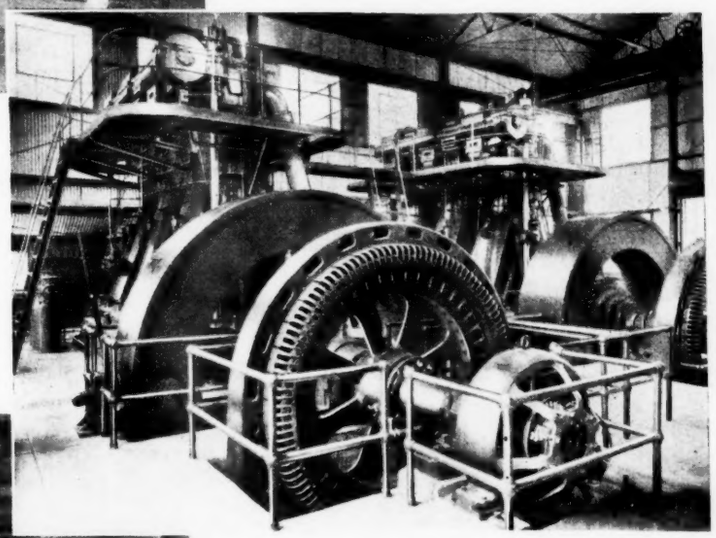


Fig. 2 (Right)—Two 520-hp. Diesels installed in iron-mine plant located in the Ozark region of Missouri

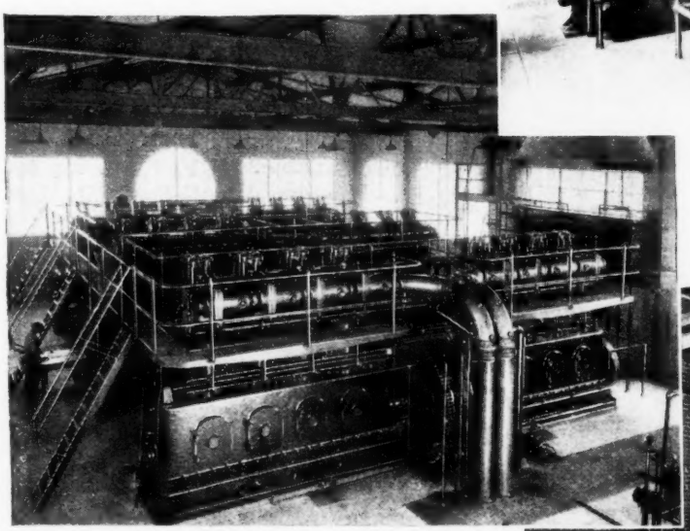


Fig. 3 (Left)—A Nevada cement mill has three 800-hp. oil engines in its power plant

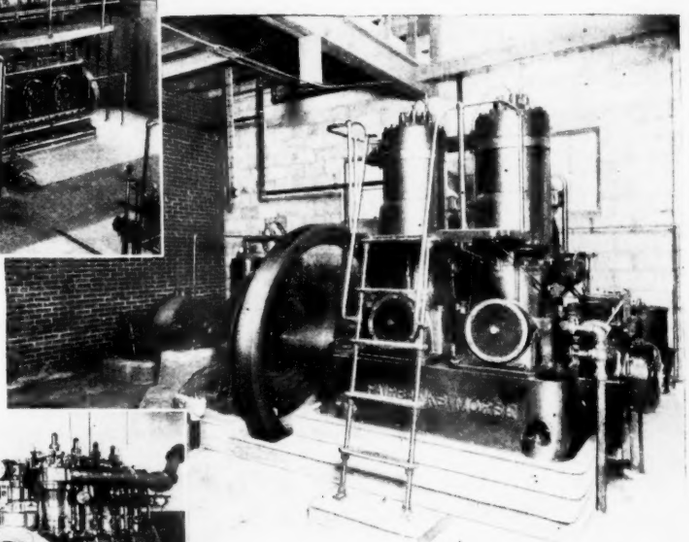


Fig. 4 (Right)—Packing houses use oil engines. This one is in an Indiana plant

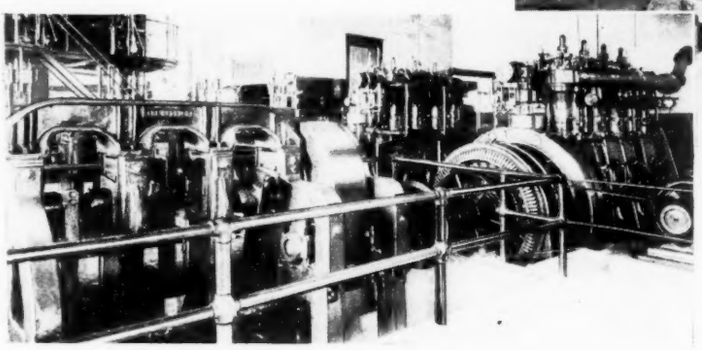


Fig. 5 (Left)—Two Diesel engines direct connected to triplex pumps in a South Dakota water works

Pulverized Coal in the Industrial Plant

ALTHOUGH it is only within the last three or four years that pulverized coal has been made economically applicable to the small or medium-sized industrial power plant through the developments of the unit system of firing, few if any plants are now designed or alterations made to existing ones without pulverized coal being given due consideration.

As practically all the early developments and improvements were carried out in the large central station and on comparatively large boilers, the impression was created among engineers in general that pulverized coal was applicable only to large plants. This resulted in little or no attention being given to the small plant. Although pulverized fuel is still in a state of development and subject to a number of refinements, the reliability and efficiency of this method of firing have been thoroughly demonstrated.

In general it might be said that the essential requirements of a pulverized-coal system for a small plant are

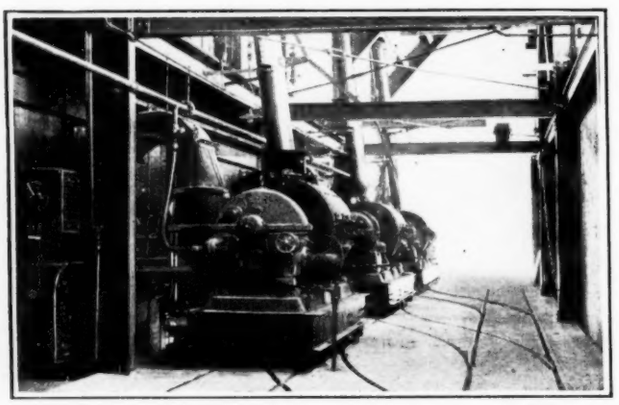


Fig. 1—At a Mexican plant of the American Metal Co. the pulverizers are mounted on trucks

simplicity, low first cost, small maintenance and minimum attendance. The unit system appears to most nearly meet these requirements. It is not to be assumed, however, that this system is equally adaptable to all installations. Each plant, large or small, presents a separate economic problem, and the selection of the equipment can be made only after a survey of local conditions and consideration of the relative advantages and merits of each system.

One point in favor of the unit mill is that it can usually be installed without material changes in the existing plant. This feature is an advantage when adapting this method of firing to boilers already in service, as many of these are set low and do not permit of the large furnace necessitated by the long flame travel. Unit pulverizers now available range in capacities from 1,000 lb. to 10,000 lb. of coal per hour, which permits a wide field of application.

Although no distinct lines can be drawn at present to indicate the field of application of the two systems, it is generally conceded that where the daily coal consumption is less than 200 tons, the unit system is undoubtedly the best selection, depending of course upon local conditions and whether the installation is new or an alteration to an existing plant.

An analysis of local conditions may show that the coal unloading or reclaiming equipment, conveying system and coal bunkers are in place and could not be used with a central preparation plant, but are well suited to a unit system by placing the pulverizer in front of the boiler and taking the coal from the existing bunker. On the other hand, the high operating cost of the existing method of handling the coal where the plant is necessarily located a considerable distance from the point of unloading may make the adoption of a storage system desirable.

One Company Converts Ten Hand-Fired Boilers to Pulverized Fuel

A typical illustration of the storage system in an industrial plant is that of the Clark Thread Co., Newark, N. J., in which ten 4,270-sq.ft. boilers have recently been converted to pulverized coal. Previous to making the change, the boilers were hand-fired with No. 3 buckwheat, which was received by barge and then transported by motor trucks to the boiler house.

As the point of unloading the coal was approximately 800 ft. from the boiler room, the preparation plant was built adjacent to the point of unloading, and the coal is now transported to the boilers in pulverized form through a 5-in. pipe line placed underground. Changes to the existing furnaces included carrying the front wall forward about 5 ft. and lowering the floor of the combustion chamber 3 ft. This increased the furnace volume from 850 to 2,550 cu.ft. The alteration to the furnace and the installation of the fuel bins and feeders were made without any alteration to the boiler house.

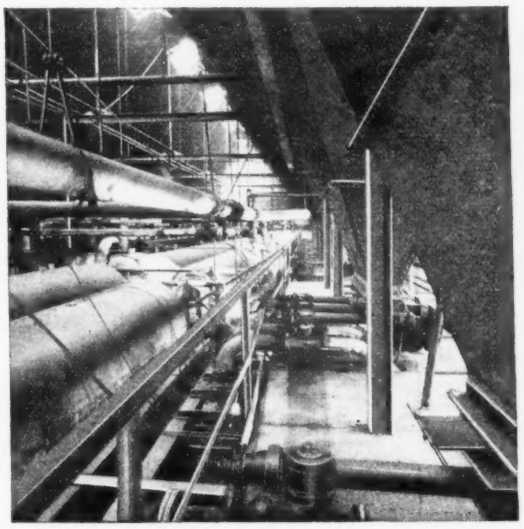
To secure the same reliability with the unit mill as is afforded by the storage system, it is necessary to have the unit mills so arranged that there are spares available.

An installation in which no spare mill is provided for a group of three boilers, but the pulverizers are readily interchangeable, is illustrated in Fig. 1. Each boiler is fired by a unit pulverizer, one being steam driven and two motor driven. Each machine is mounted on a truck, and parallel tracks and switches are provided to facilitate transferring the units from one boiler to another. In the case of the steam-driven machine the live- and exhaust-steam connections are made by means of flexible hose connections.

Unit Mill Fires Colorado Lignite

One advantage of firing with pulverized coal is that any coal can be burned and with a small excess air supply. Fig. 4 shows two 2,000 lb. per hour capacity pulverizers each firing a 2,500-sq.ft. vertical water-tube boiler. The coal used is Colorado lignite containing around 25 per cent moisture and 9,000 B.t.u. as fired. The pulverizers are placed on a gallery and the coal is fired vertically through openings in the top of the combustion chamber, the furnace volume in this installation being 1,680 cu.ft. Figs. 5 and 6 show typical unit installations.

There is need for accurate operating information and maintenance data on the unit system as well as the central preparation plant, so that these costs may be included when considering pulverized coal for a new plant or changes to existing installations.



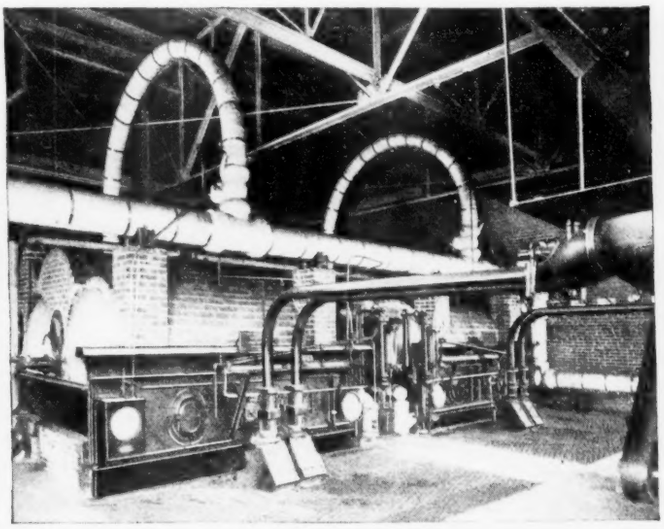
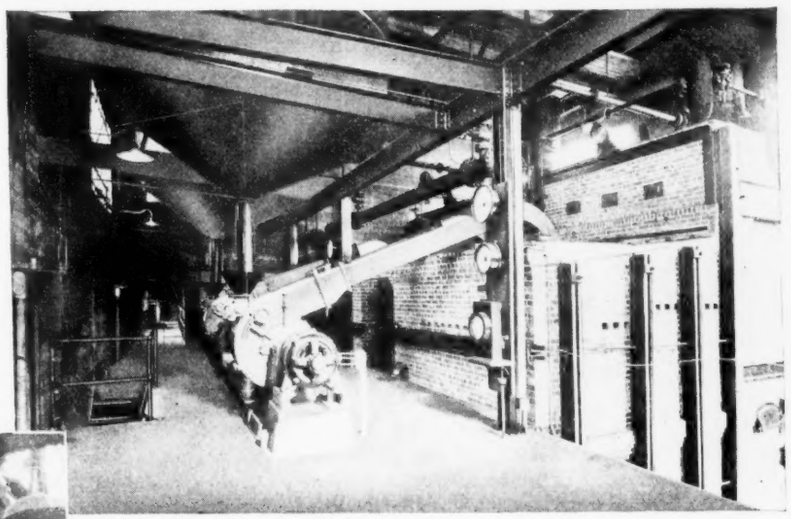


Fig. 2 (Above)—Feeders and burners, Clark Thread Co

Fig. 3 (Upper Right)—Operating floor, Ohio Brass Co.

Fig. 4 (Right)—Unit installation in Colorado, firing lignite

Fig. 5 (Below)—Typical unit installation



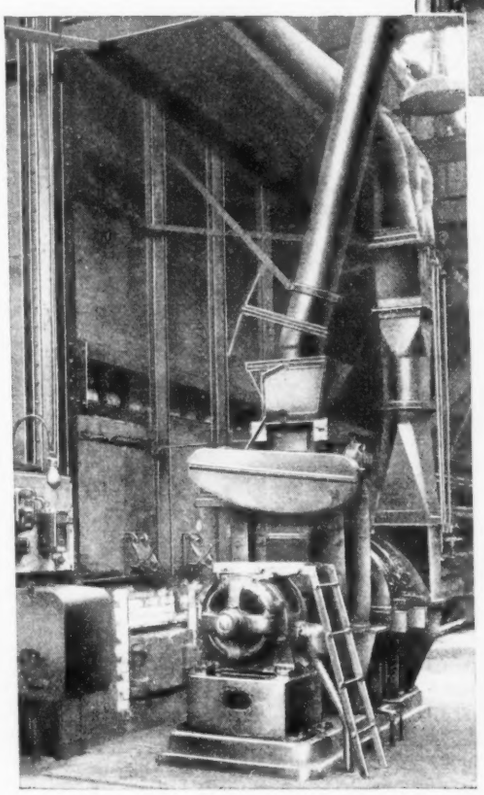
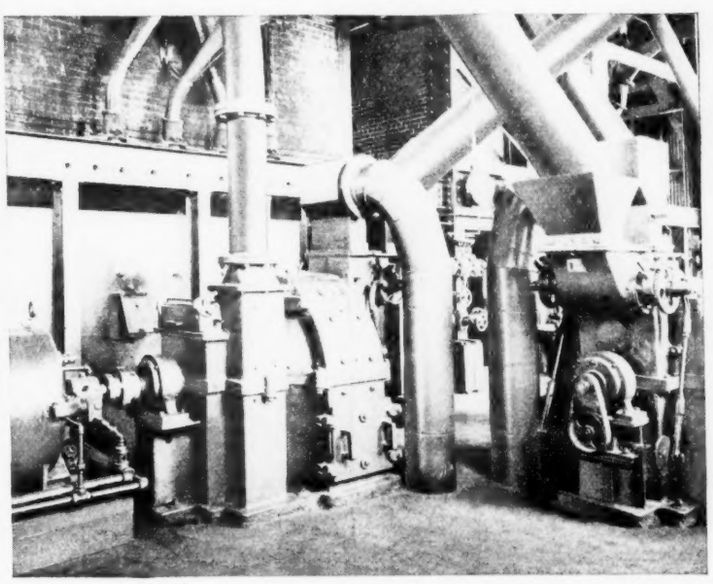


Fig. 6 (Below)—Pulverizers are steam and motor driven at Daily News Corp., North Tonawanda, N. Y.



Mechanical Stokers Offer Savings to Many Hand-Fired Plants

THERE is probably no better opportunity for reducing the cost of operation of the average power plant than by improving the methods of combustion of the fuel used. In a surprisingly large number of the industrial plants throughout the country the boilers are being run around 50 per cent efficiency, with low boiler settings, hand firing and other obsolete methods. In the majority of these plants the average boiler efficiency could be increased at least 15 to 20 per cent by a slight modification of the boiler furnace and the installation of a mechanical stoker.

No arbitrary ruling can be made as to the minimum size of boilers under which automatic stokers can be economically installed or the minimum size of plant that can be economically so equipped; each case must be decided on its merits.

One of the most apparent advantages in the use of mechanical stokers is the saving in boiler-room labor, particularly in the larger plants. In plants where the weekly coal consumption will run between 150 and 200 tons, the saving in labor may reach 40 per cent; in the small plant it may be comparatively little, but the increase in efficiency due to more uniform feeding of the coal and the increase in flexibility of operation should not be overlooked. In cases where additional capacity is needed, it can often be secured by installing mechanical stokers under the existing boilers and thereby increasing the steam output of the present plant instead of installing an additional boiler.

Stokers are now available in hand- and power-operated types and sizes suitable for practically any size of plant and kind of coal, so the problem is essentially one of first cost and choosing a stoker suitable for the plant under consideration and the kind of coal to be burned.

Proper Selection of Stoker Necessary

The different coals throughout the country possess widely differing characteristics requiring conditions peculiar to each particular coal for the best combustion results. Each stoker has been developed to meet some certain set of conditions, and while it may be said that every stoker will burn practically every coal with some degree of success, no stoker should be expected to operate successfully with every coal. In cases where stokers have failed to meet expectations, the failures have usually been due to improper selection rather than to any inherent weakness in the stoker.

Before selecting a stoker for any particular plant and to meet any given set of conditions, a survey should be made of the coals commercially available, bearing in mind that the kind offered at the lowest price is not necessarily the cheapest fuel.

With the survey completed and an analysis made of the conditions under which the stoker will have to operate, it will not be difficult to choose a stoker that will fill the requirements successfully.

The type of grate or stoker used depends, as before mentioned, upon the kind of coal that is to be burned, upon the load conditions, ratings desired, and to some extent upon the type of boiler. If there are sudden overloads or peak conditions, obviously a forced-draft stoker should be considered. On the other hand, if the load is fairly uniform and it is intended to operate the boilers at high ratings, a natural-draft type may be preferable.

Where the coal is free-burning with comparatively little coking tendencies, overfeed or chain-grate type stokers are best adapted to the fuel, while if the coal is a low-grade product or a small-sized anthracite is to be burned, a forced-draft chain grate is desirable. If, however, the coal is of a medium or heavy coking variety, as are most of the Eastern bituminous coals, an underfeed stoker, which is essentially a forced-draft stoker, should be used.

Size of Plant an Influencing Factor

As a large number of the industrial power plants are of comparatively small power, the hand-operated or semi-mechanical stokers have a wide range of application. Although no distinct line can be drawn, it would appear that in a plant where two or three boilers of around 1,500 sq.ft. of heating surface are operated for eight or ten hours a day a hand-operated stoker would be suitable, but if the same plant operated 24 hours a day a power-operated stoker should be used. A number of manufacturers of hand stokers are now offering a duplicate stoker equipped with a hopper feed and an electric or hydraulic motor to operate the feeding mechanism and the stoker bars for propelling the coal downward across the grate.

One of the essential requirements of a successful stoker installation is proper draft. Failure to provide for the necessary draft to cover the range of rating through which the boiler is expected to operate has been the cause of the majority of troubles encountered with mechanical stokers. The choice between natural, induced and forced draft is influenced by local conditions and the rating at which the boilers are to operate. The necessity for flexibility in the boiler plant to meet the varying grades of coal and the increasing tendency to operate boilers at high ratings has made mechanical-draft apparatus an essential part of the steam-generating equipment.

Other contributing factors to the success of a stoker installation are the design of the furnace and in case of the over-feed or chain-grate types, the length of the ignition arch and the height of the arch above the fuel bed. In the selection of new apparatus it is possible to proportion the boilers, stoker and furnaces for the best results, but in the case of an old installation this cannot always be done. Many boilers that are still in condition to give good service for years and therefore cannot be discarded, are not proportioned for stoker firing. In such cases the stoker must be proportioned to suit the boiler if best results are to be secured. Some types of stokers are made in a variety of sizes and are therefore easily applied to such cases.

Little need be said on the subject of reliability of the stoker, for as a unit this is one of the most reliable pieces of apparatus in power-plant equipment provided it is intelligently operated and maintained.

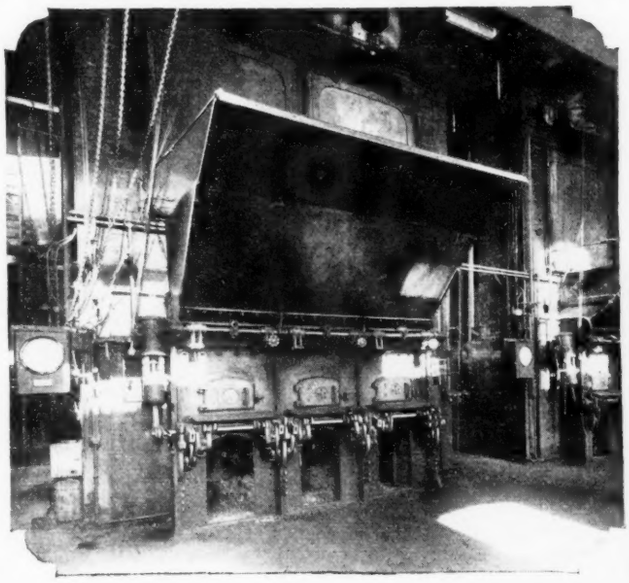


Fig. 1 (Left)—Hydraulically operated stokers at the Liondale Bleach Dye & Print Works, Rockaway, N. J.

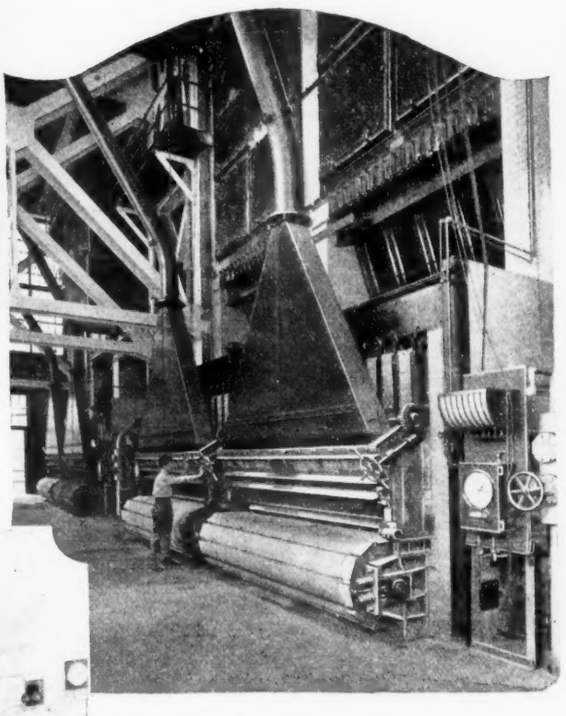


Fig. 2 (Right)—Traveling-grate stokers firing buckwheat, Kearny Plant, Western Electric Co.

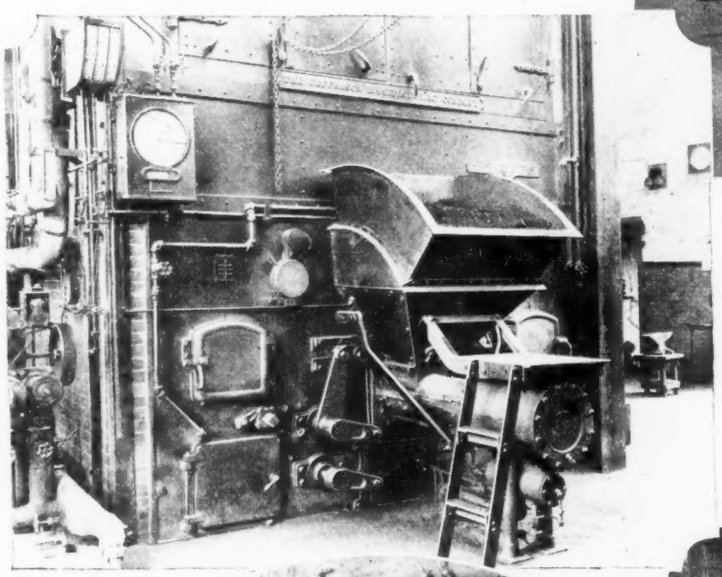


Fig. 3 (Left)—Lateral retort stoker under a 4,000-sq.ft. boiler. Jefferson Manufacturing Co.

Fig. 4 (Below)—Underfeed stoker installation in West End plant, Fisher Body Corp., Detroit

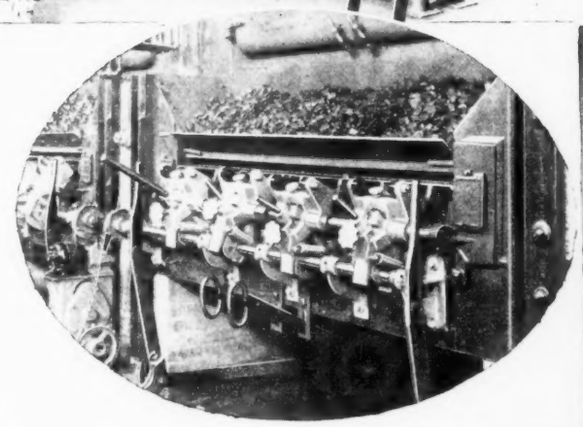
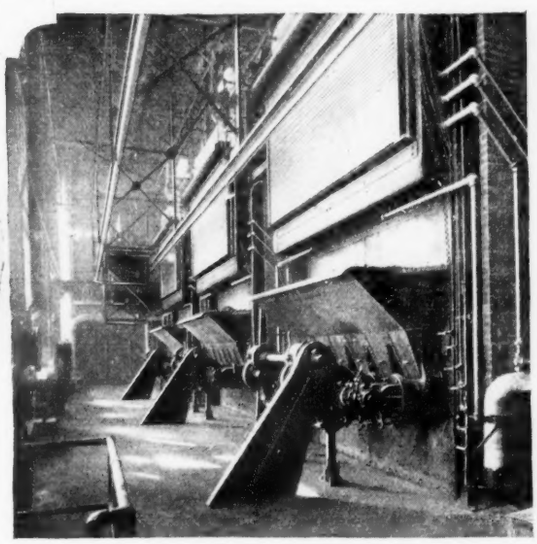


Fig. 5 (Above)—Hopper-fed hand stoker equipped with power drive



High Efficiency in the Use of Steam

THE steam turbine is well adapted to combined power and heating processes, in which the power may be generated at efficiencies of 50 per cent or higher, the oil-free exhaust steam being used for furnishing heat. This article discusses this combined process and cites examples of practical applications that are earning dividends for their owners.

IN THE industrial power plant an important line of advance is the use of turbines designed to furnish exhaust or extracted steam for process heating, at whatever pressures the processes may require. Turbine applications of this sort, producing power as a byproduct through the use of steam that would be made in any case for heating purposes, show surprisingly high thermal efficiencies if a fair credit is allowed for the useful heat in the exhaust or bled steam.

In figuring the thermal efficiency of a power generating process, the heat equivalent of the useful work developed is divided by the heat supplied for the generation of power. In a simple steam plant exhausting to atmosphere or to condensers the useful work may be as low as 5 per cent of the heat in the fuel.

The largest single loss in the usual steam plant is the heat in the exhaust steam. If conditions make it possible to reduce or eliminate this loss, the plant economy will be much improved.

For example, consider a plant in which steam is generated at 125 lb. per sq.in. gage and used in an engine or turbine exhausting to atmosphere. With a steam rate of 50 lb. per kw.-hr. the exhaust steam will have a quality of 96 per cent; that is, for each hundred pounds of steam supplied, the exhaust, if passed through an effective separator, will yield 96 lb. of dry steam at atmospheric pressure. The thermal efficiency of the engine is about 8 per cent. If the boiler efficiency is 70 per cent, the entire plant will stand at about 5.6 per cent.

Now suppose that the exhaust steam can be used to heat the building served by the power plant. In addition to the power generated, there is a useful supply of low-pressure steam. How shall the efficiency be computed?

One kilowatt-hour of engine or turbine output will still require the supply of 50 lb. of steam at 125 lb. per sq.in. gage, but there will be delivered to the heating system $0.96 \times 50 = 48$ lb. of dry steam at atmospheric pressure. If the boiler is fed with water at 200 deg. F., each pound of steam generated at 125 lb. per sq.in. requires 1,024 B.t.u., so that the 50 lb. will require $50 \times 1{,}024 = 51{,}200$ B.t.u. Similarly, if heating steam were made in separate boilers at atmospheric pressure, each pound would require 983 B.t.u., and 48 lb. would require $48 \times 983 = 47{,}200$ B.t.u.

The balance sheet for power efficiency under these conditions is given in the accompanying table. It must be remembered that this table does not include boiler-room losses. If the efficiency of the boiler room is 70 per cent, the over-all thermal efficiency of the power process will be $0.70 \times 0.85 = 0.60$; that is, the heat converted into useful work will be about 60 per cent of that portion of the heat supplied in the fuel which is fairly chargeable against power generation. The greater part of the fuel would have to be burned in any case to supply the heating steam, even if the turbine or engine were not used.

As a matter of fact, this imaginary case is too good to be true. Usually, there is too much or too little exhaust steam for the heating requirements, or put-

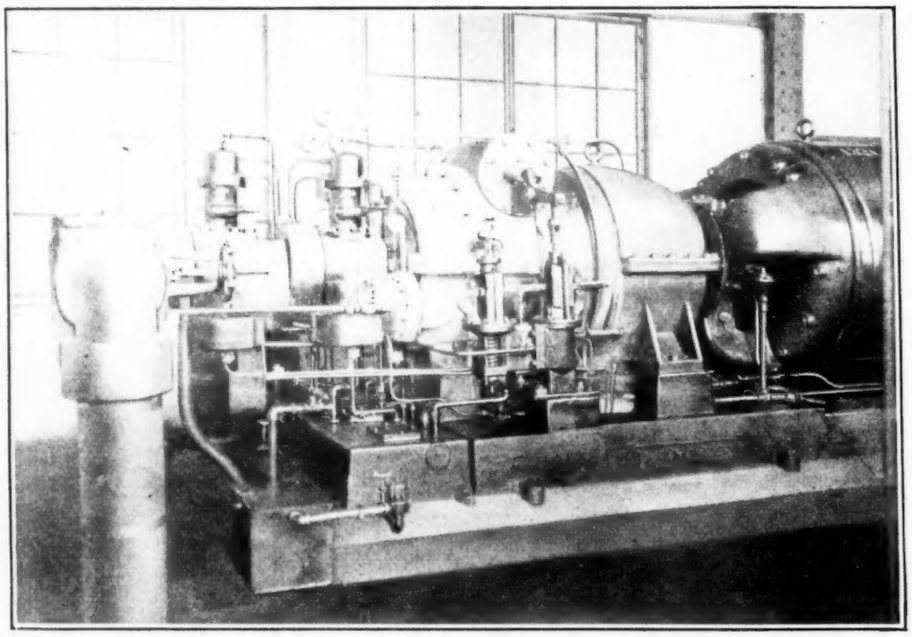


Fig. 1—This turbine furnishes steam at 65 and 15 lb. per sq.in. for process heating in a soap factory

The power generated displaces purchased power, and its fuel cost is extremely small.

ting the matter in another way, the power demand and the heating demand do not balance and both vary differently with weather conditions and seasons. When these are balanced, the fuel cost chargeable against power generation is likely to be about one-quarter of that obtainable with a good condensing plant, but this is only part of the story. At times when these demands do not balance, conditions are not so favorable. When the power demand is such that the exhaust steam is insufficient to supply the heating requirements, live steam must be used to make up the deficiency. This may not prove very unfavorable; certainly, it is no worse than supplying all the heat with live steam, generating no power at all. The other extreme, on the contrary, is more wasteful. When the power demand is large and the heating demand small, so that the exhaust steam cannot all be used, the excess exhaust must be wasted to the atmosphere, and the corresponding portion of the power will be generated at very low efficiency. In many cases it would be cheaper to purchase power.

EFFICIENCY BALANCE SHEET FOR COMBINED POWER AND HEATING PROCESS

Charge 50 lb. of steam at 125 lb. per sq.in. gage	51,200 B.t.u.
Credit for heating 48 lb. of dry steam at atmospheric pressure	47,200 B.t.u.
Net charge against power generation	4,000 B.t.u.
Credit 1 kilowatt-hour generated	3,413 B.t.u.

$$\text{Thermal efficiency} = \frac{\text{output}}{\text{heat chargeable}} = \frac{3,413}{4,000} = 0.852$$

Accordingly, special study is required in each case, balancing the period during which high efficiency is possible against the period in which only a low efficiency is obtainable. An exact and continuous balance is rare.

In general, however, it is true that every attempt to find a use for exhaust steam and every attempt to find exhaust steam for a heating requirement is a step in the direction of maximum plant economy and minimum cost to the owner.

The plant engineer should examine his plant with this in mind. Here is steam exhausting to atmosphere or to a condenser. Is there not some heating job for which this steam or a part of it could be used? Here is a process in which heat is supplied in live steam. Would it not pay to install a turbine or an engine, with a high-pressure boiler plant, and use the exhaust for this heating requirement? Of course the answer is not always affirmative. Each situation demands special study, and no man is safe in simply assuming that his plant has the best layout.

The steam turbine is especially well adapted to service of this kind because its exhaust is free from oil whose presence in the exhaust steam from engines is often objectionable for process work. Turbines may be designed to operate with any desired exhaust pressure, and if steam is needed at more than one pressure, a turbine may be arranged with steam bleeder connections so as to meet the heating requirements and at the same time generate the maximum of power from the steam so used.

Examples of how this problem has been worked out cover a wide range. In a large soap factory there is a 500-kw. turbine receiving steam at 180 lb. per sq.in. and furnishing steam at two different pressures for process heating. The main exhaust is at 15 lb. per sq.in., with a bleeder connection furnishing steam at 65 lb. per sq.in. Both steam quantities vary independently under automatic control with no attention from the operators. The entire output of the generator is absorbed in the plant, displacing purchased power.

A rubber factory[1] requiring steam for heating at a pressure of 100 lb. per sq.in. and having a large power demand as well, operates a turbine receiving superheated steam at 250 lb. per sq.in. and exhausts at 100 lb. per sq.in., the exhaust steam being somewhat superheated. When the power demand falls off, so that there is not enough heating steam, reducing valves supply live steam.

The central heating plant described on another page of this issue of *Power* is an excellent example of the generation of byproduct power. In this case the enforced idleness of the turbo-generator during the summer is an important consideration, and in some situations it is cheaper to omit the power equipment.

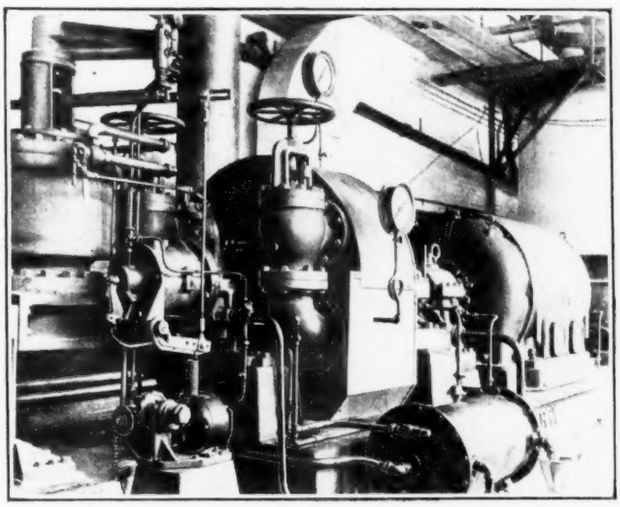


Fig. 2—Steam is exhausted from this turbine at 115 lb. per sq.in. for use in a pulp mill

Automatic controls maintain a constant exhaust pressure

Another application of the high back-pressure turbine is in increasing the capacity of existing plants. In one case, for example, the present plant operates at a pressure of 135 lb. per sq.in. An addition now under construction will comprise two boilers to operate at 450 lb. per sq.in., and a turbine receiving steam at 435 lb. per sq.in., exhausting into the existing 135-lb. steam system. The added power will be generated at little increased fuel cost, and this turbine will deliver substantially dry exhaust steam, which will be used for exactly the same work that now requires live steam produced by burning fuel.

In the production of paper pulp, large quantities of steam are required, and in one New England plant there is an interesting installation of turbines exhausting at a pressure of 115 lb. per sq.in. The quantity of steam required by the heating process varies widely, and automatic controls maintain a constant pressure.

Examples might be multiplied, but the principle is the same in every case. The operating engineer who is alive to his opportunities should work out his own problem in collaboration with the engineers of the turbine manufacturers, who are in a position to suggest possibilities that may open the way to the generation of both power and heat at a combined cost well below that involved in the purchase of either or both.

[1] See *Power* for May 26, 1925, page 825.

Put the Idle Horses to Work!

DO YOU extract the power from your steam before sending it to process and heating coils? By raising the steam pressure and installing an engine or turbine, the steam you now generate for process and heating alone can turn out a lot of byproduct power without appreciably increasing your coal bill.

Again, where the power required exceeds that obtainable in this manner, a bleeder turbine may be installed. This will squeeze a maximum of power from the steam used for process or heating, allowing any excess to expand completely to condenser pressure.

How much power can one "skim" from steam in this way? It depends mainly on the steam pressures and to a lesser degree on the quality of the engine or turbine used. The simple diagram in the adjoining column shows graphically how much a "perfect" engine will abstract from a steam flow of 100 lb. per hour. While exact for one condition only,[1] the chart is useful for rough estimates over the entire range of ordinary practice.

For instance, suppose steam is used by the process at 5 lb. gage pressure and is generated (or can be generated) at 180 lb. gage. Locate these gages on the chart and count the number of horses between them. The count shows seven horses, which means that a perfect engine taking steam at 180 lb. and exhausting at 5 lb. will extract approximately seven horsepower for each hundred pounds of steam flowing per hour. An actual engine or turbine should recover from 50 to 80 per cent of this, say about 5 horsepower.

If process and heating require 8,000 lb. (80 × 100) of steam per hour, such an engine or turbine could recover 5 × 80 = 400 hp. from this steam.

The cost of developing power in this manner is extremely small. The additional coal consumed is approximately one-third pound for each horsepower-hour actually developed, regardless of the type of engine or turbine used. Where the existing boilers can produce the necessary pressure, the fixed charges are also small.

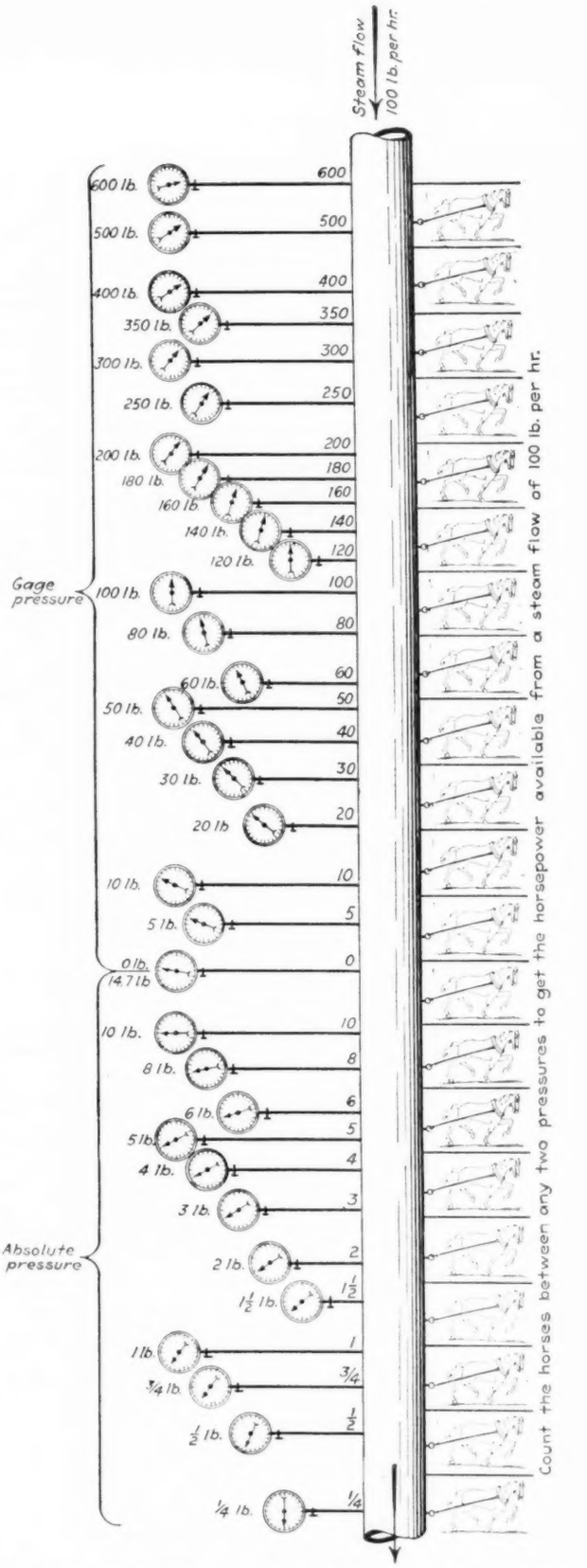
Many process plants still fail to take advantage of their opportunities in this respect. Various excuses are offered. Some owners imagine that it takes a lot more coal to produce high-pressure steam. Others overestimate the steam pressure necessary for the process. Often investigation proves that the process can be handled as well with low pressure as with high.

It would, of course, be absurd to claim that steam should *never* be used directly for process or heating without passing it through an engine. There must exist a considerable flow of steam and enough power demand to make generation worth while.

There are many methods of salvaging power from process or heating steam. Every "hookup" of the radio fan can be matched by a power-process-steam layout. A few of the more common arrangements are shown on the facing page.

These will indicate some of the possibilities. Before making an actual layout, the power and process demands, as well as special local conditions, should be carefully analyzed by an expert in such matters.

[1]Expansion along an "adiabatic" line through 200 lb. and 100 deg. superheat.

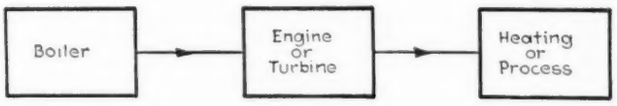


Power obtainable from a steam flow of 100 lb. per hour through a perfect engine

An actual engine or turbine will generally develop from 50 to 80 per cent of the power indicated by the chart. Count the horses between the available initial and final pressures. Take from 50 to 80 per cent of this number (estimated according to operating conditions and size and type of engine or turbine.) Multiply the result by the actual flow of steam available, measured in *hundreds* of pounds per hour. The result is the total amount of power practically obtainable from the given flow of steam.

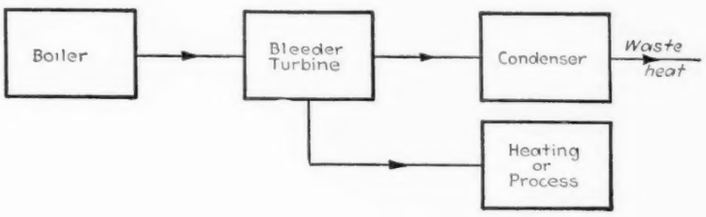
Byproduct Power

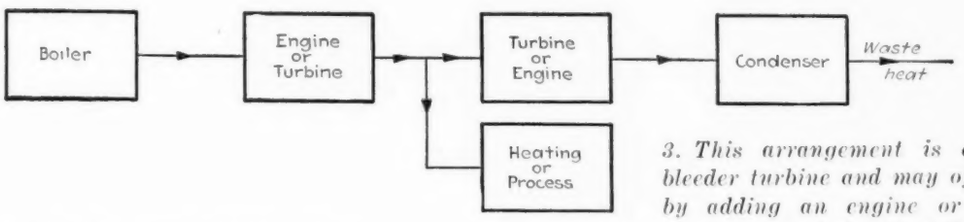
Seven Ways to Get It from Steam Needed for Process or Heating



1. The simplest and most common arrangement is to exhaust directly to heating or process

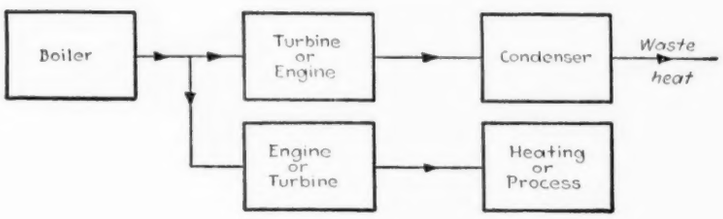
2. Steam for heating or process may be extracted from a condensing bleeder turbine. Steam not needed for heat develops its maximum power by expanding to condenser pressure

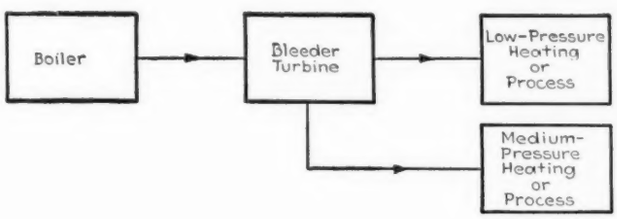




3. This arrangement is equivalent to a bleeder turbine and may often be obtained by adding an engine or turbine to an existing installation

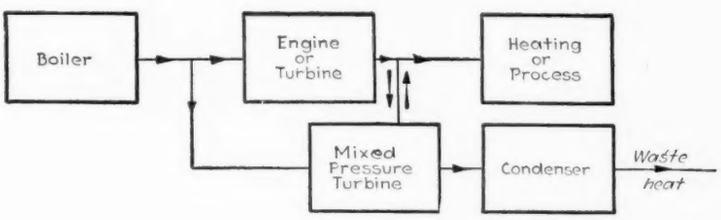
4. Another arrangement equivalent to a bleeder turbine. Condensing turbine generates any required excess of power over that furnished by engine exhausting to process

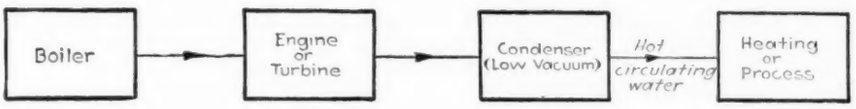




5. This "hook-up" gives two supplies of heating and process steam at different pressures

6. Mixed-pressure turbine can add to process-steam supply or absorb excess as power and process loads vary





7. Some plants now heat buildings with hot circulating water from the condenser, thus extracting the maximum amount of power from the steam

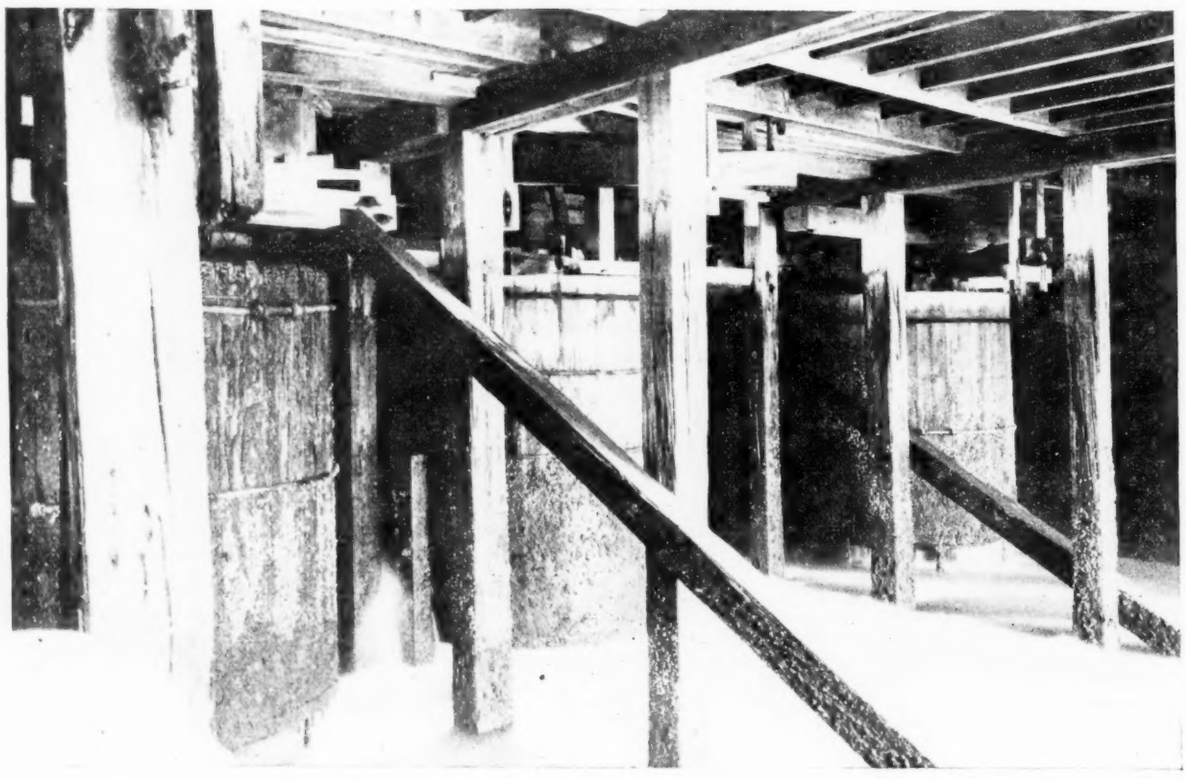
Looking across the millpond

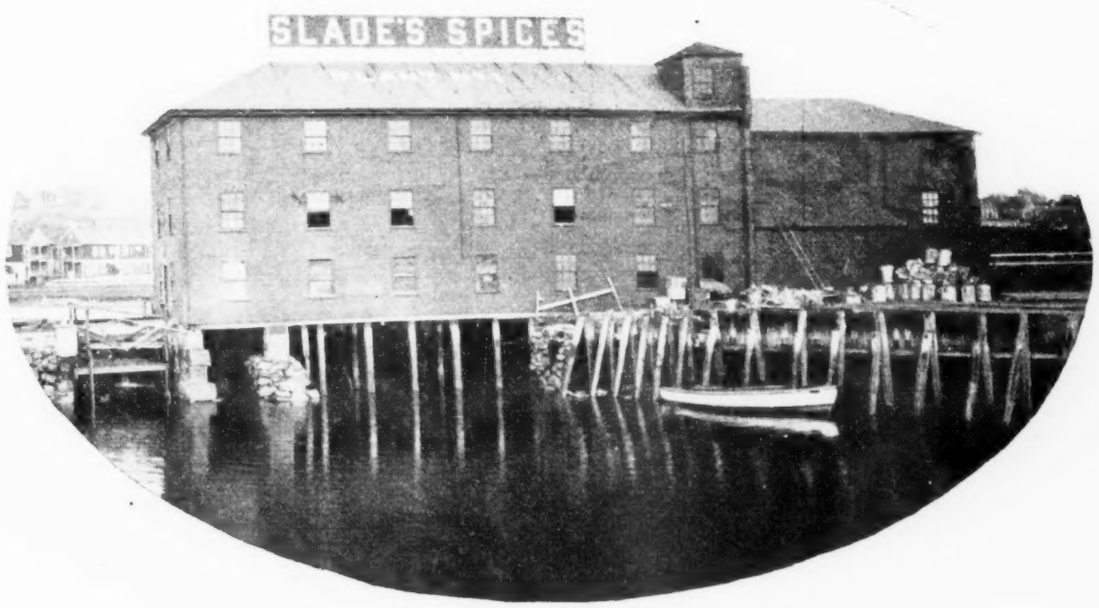
The wheels are under the right third of the mill. The long signboard at the right of the mill is supported above the automatic check gates which let the tide into the pond.

Old Tide Mill Still Grinds Spices

IF YOU ever go to Boston, it will be worth your while to run out to Chelsea to view the old tide mill. Perched on the edge of its salt-water millpond, the Rumney Marsh of Colonial days, it has been running since 1816, when it replaced a burned-down tide mill built in 1734. Altogether this site has witnessed nearly 200 years of continuous tide-mill operation. Since 1837 Slade's spices have been ground here preparatory to blending and packing elsewhere with modern machinery.

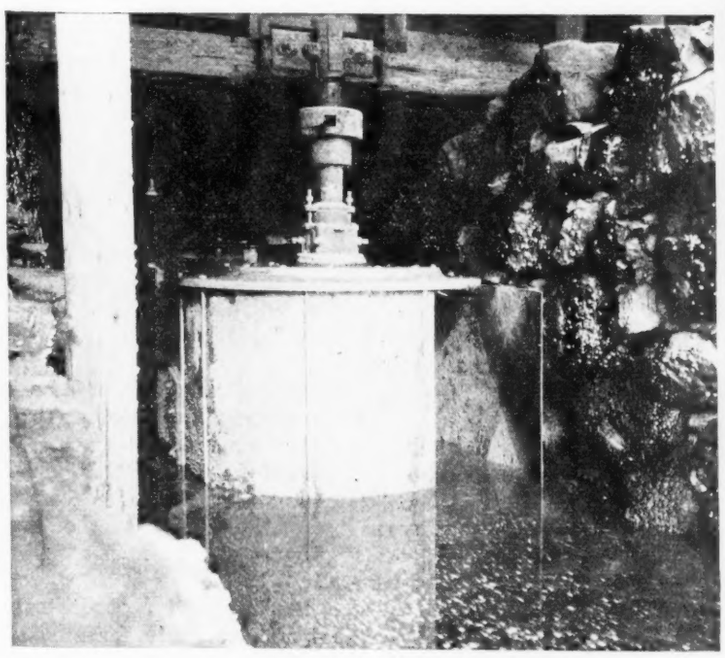
Salt water rushing back to the sea at low tide through the barnacled wooden casings of three old propeller-type wheels. Spices are being ground on the floor above. A 25-hp. motor helps out when the tide is not right



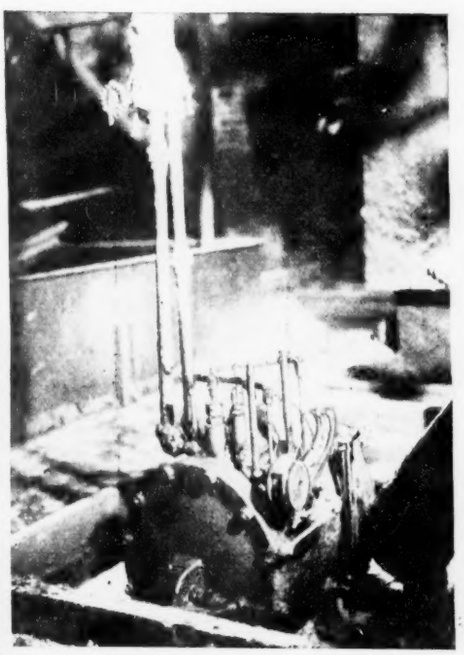


View of mill from the discharge side at low tide

A corner of the millpond is visible at the left. In the stone-lined tailrace at the left end of the mill is the iron-cased wheel shown below, while the wooden-cased wheels shown on the facing page are housed between the posts at the right of this.



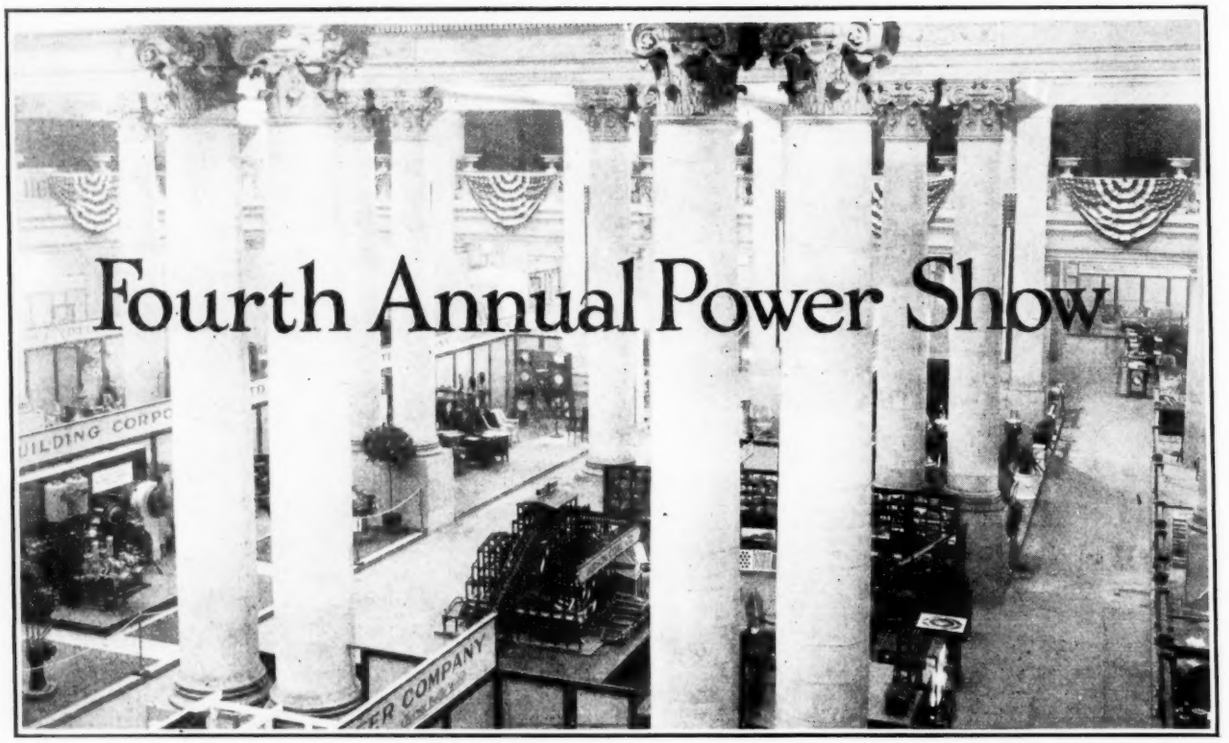
The iron casing indicates that this is the most "modern" wheel in the bunch. Incidentally, salt-water corrosion has put it out of commission, while the other wheels spin merrily along



This picture has no relation whatever to the others except that it shows another engineering curiosity in the same Boston region

The trap shown, built to handle condensate, is here engaged in the unpleasant task of pumping "tallow" (polite term for blood and animal oil) from "percolators" to the fifth floor of a local slaughterhouse.

Photo taken with co-operation of Sterling Engineering & Mfg. Corp.



AN OUTSTANDING feature of the Fourth Annual Exposition of Power and Mechanical Engineering being held this week at the Grand Central Palace, New York City, is the number of exhibits featuring equipment that has been brought out during the last year. These new developments cover practically all branches of power-plant equipment and serve to indicate the recent activities in that field.

The number of exhibitors has increased considerably over the previous expositions, and included in the present list are some of the largest manufacturers of power-plant equipment. Several of the exhibitors who have shown their products each year since the inception of the show four years ago have increased their space, which attests the success of the show from a business point of view.

The exposition is being held simultaneously with the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers, as has been done the last two years.

As in former years stokers and pulverized-coal equipment are much in evidence. Of the nine types of pulverizers on exhibit, four are being shown for the first time, three of which are of comparatively recent development.

Other products on exhibit which are closely allied with the fuel-burning equipment are two types of water-cooled furnace walls and three types of air preheaters. In one type of water wall shown, the water tubes are exposed to the radiant heat of the furnace with the tile and insulation on the outside, while in the other the water tubes are on the outside and are faced with refractory blocks suspended from the tubes. A sectionally supported furnace-wall construction for use on furnaces of the hollow-wall type will also be shown. In this wall sections approximately 4 ft. in height are supported independently, which permits replacing any block in any one section without disturbing the rest of the wall.

A new development in the line of economizers that is being shown is a lead-coated steel-tube machine designed to resist the external corrosion caused by sulphuric acid in the flue gases and the internal corrosion due to oxygen in the water. The tubes have extended surfaces.

As at the previous expositions, working models are being used to demonstrate the working principles of certain types of equipment where it has been found impracticable to exhibit the full-sized commercial units. In some cases these are amplified with drawings and photographs to illustrate the different applications.

Included in the list of prime movers are a six-cylinder gasoline engine of 225 hp. designed for emergency or stand-by service, also a crankless engine of 50 hp., which in design is a radical departure from the usual practice. One company will exhibit the cylinder, piston and piston rod of its double-acting two-stroke-cycle Diesel engine.

The boiler-room instruments on exhibit will be found to cover a wide range of applications in the power-plant field, and many new instruments are included. In the exhibit of mechanical soot blowers one type is shown in which the main-line steam valve and the blower elements are electrically operated. In another type a double-tube air-cooled element and a simple monel-metal sheathed element are shown.

A series of lectures for engineering students and a program of motion pictures are again features of the exposition.

The foregoing mention of some of the new and improved devices that are being exhibited has been made possible through information furnished in advance by the manufacturers; a more complete description of the show will appear in the Dec. 8 issue. A list of the manufacturers and their products follows:

EXHIBITORS AT THE POWER SHOW AND THEIR PRODUCTS

Booth No.	Manufacturer	Product
476	Accurate Brass Casting Co., Inc., Brooklyn	Brass castings.
423	Ackerman-Johnson Co., Chicago	Expansion bolts and hangers.
275	Advance Engineering Co., New York	"Armstrong" high- and low-pressure traps.
319-320	Aero Pulverizer Co., New York	Coal pulverizing and burning equipment.
234-235	Air Preheater Corp., New York	Air preheaters.
443	Ajax Wrench Corp., New York	Wrenches.
434	Alexander Bros., Philadelphia	Belting.
483	Allen, A., & Son., Harrison, N. J.	Bearing metals and packing.
75	Allen-Sherman-Hoff Co., Phila.	"A.S.H." Hydro-jet ash handling system, cast-iron bunkers, air-cooled furnace bottoms, ash hoppers and gates.
445-446	Allis Louis Co., Milwaukee	Electric motors and fans.
470	Allis-Chalmers Mfg. Co., Milwaukee	"Allis" texrope drive and ball bearing induction motors.
212	Alsop Engineering Co., New York	Mixing machines and portable pumps.
58	American Arch Co., Inc., N. Y.	Flat suspended furnace arches.
296-297	American Blower Co., Detroit	"Sirocco" fans, blowers and air-conditioning equipment.
65	American Brass Co., Waterbury, Conn	Copper and copper zinc products sheet, wire, rods and tubes.
207-208	American Car & Fdry Co., N. Y.	"Berwick" electric rivet and metal heaters, Halyburton valves.
475	American District Steam Co., No. Tonawanda, N. Y.	Duplex sleeve expansion joint, types of underground steam line construction reducing valves, steam traps, steam flow and condensation meters.
48	American Chain Co., Bridgeport, Conn	Chains for cranes, hoists, and other uses.
76	American Chimney Corp., New York	
429-430	American Machine & Fdry. Co., Brooklyn	Rotary pressure and vacuum pumps, automatic water supply system.
530-531	American Pulley Co., Philadelphia	Split-steel pulleys, pressed-steel shaft hangers and pressed-steel trucks.
524-525	American Resistor Co., Phila.	High-speed steel treating furnace and portable electric heating appliances.
74	American Schaeffer & Budenburg Corp., Brooklyn	Indicating and recording gages and thermometers, pop safety and relief valves, calorimeter and dial thermometers.
243	American Society of Heating & Ventilating Engineers, N. Y.	
80	American Society of Mechanical Engineers, The., New York	
510	American Temperature Indicating Co., Toledo, Ohio	Temperature indicating and recording instruments.
441	Ames B. C. Co., Waltham, Mass.	Bench lathe, milling and filing machines, dial gages.
65	Anaconda Copper Mining Co., New York	Admiralty and Muntz metal condenser tubes, nickel-bronze turbine blading, Tobin-bronze piston rods and shafting, copper busbar and tubes.
92	Andale Engineering Co., Phila.	Duplex strainers for water and oil
17	Andrews-Bradshaw Co., Pittsb'g	Tracyfiers.
232	Arca Regulators, Inc., New York	"Arca" automatic regulators.
334-335	Armstrong Cork & Insulating Co., Pittsburgh	"Nonpariel" insulting brick, high-pressure covering and cork insulation.
451	Armstrong Mfg. Co., Springfield, Ohio	Furnace grates.
275	Armstrong Machine Works, Three Rivers, Mich	High- and low-pressure steam traps.
60	Asheroft Mfg. Co., New York	Valves, gages, steam specialties.
38	Ashton Valve Co., Boston	Master pilot pressure gages and pop safety valves.
552-553	Atwood & Morrill Co., Salem, Mass	Atmospheric relief valves, reverse current valves, adjustable combustion regulator and damper regulator.
244	Automatic Primer Co., Chicago	Centrifugal pump primer.
90	Babbitt Steam Spec. Co., New Bedford, Mass.	Chain operated valve wheels and specialties.
436	Badger, E. B. & Sons Co., Boston	Expansion joints and spray nozzles.
54-55	Bailey Meter Co., Cleveland	"Bailey" pulverized-coal feeder and meter, furnace wall, meter control equipment for automatic boiler operation, boiler meters, pressure and temperature recorders and multi-pointer gages.
249	Ballwood Company, The, N. Y.	Pipe, bends and coils.
547	Barco Mfg. Co., Chicago	Lubricated balanced plug valves and flexible joints.
313	Barnes & Jones, Boston	Modulation valves, thermostatic return traps, blast traps and condensators.
344-345	Bartlett-Hayward Co., Baltimore	"Fast's" shaft couplings.
550	Bassick Mfg. Co., Chicago	Lubricators and forced lubricating systems.
216	Bayer Company, St. Louis	Mechanical soot blowers, with double-tube air-cooled elements and single-tube monel metal sheathed elements.
504	Bearium Bearings, Inc., New York	Shaft bearings.
50-51	Beaumont, R. H., Co., Phila.	Skip hoists with simplex loader and tail block car, pivoted ash gate and ash sluice.
51	Beaumont Mfg. Co., Philadelphia	
78	Bernitz Furnace Appliance Co., Boston	Clinker-proof furnace walls and blocks.
70-71	Beshlehem Shipbuilding Corp., Bethlehem, Pa	Oil-burning equipment and boiler-feed pumps.
514-515-522-523	Bethlehem Steel Co., Bethlehem, Pa	Coal pulverizer.
68	Bigelow Co., The, New Haven, Conn	"Bigelow" water-tube and return-tubular boilers.
442	Bilton Machine Tool Co., Bridgeport, Conn	Machine tools.
535	Bird Archer Co., New York	Boiler chemicals.
563	Bishop & Babcock Mfg. Co., Cleveland	Fans, blowers, radiator traps and thermostats.
244-245	Blackburn-Smith Corp., N. Y.	Feedwater filters and grease extractors, multi-duct strainers for water and oil.
10	Boig & Hill, New York	"Curtis" steam specialties.
481	Bolinders Co., Inc., New York	Oil engine-driven generator set and oil-engine driven centrifugal pump.
340-341	Boston Gear Works Sales Co., Norfolk Downs, Mass	Speed-reduction units, silen chain drives and spur gears.
567	Botfield Refractories Co., Phila.	"Adamant" firebrick cement.
424	Bowser, S. F. & Co., Inc., Fort Wayne, Ind	"Bowser" oil-pumping, storage and purification systems.
247	Bradley Washfountain Co., Milwaukee	Wash fountains.
12	Bristol Company, The., Waterbury, Conn	Recording pressure and vacuum gages, electric temperature controls, indicating and recording thermometers and pyrometers.
88	Brown Instrument Co., Phila.	Electric Co_2 recorder combined with flue-gas temperature pyrometer, motor-operated damper control, pyrometers, two and three-pen recording thermometers and liquid-level indicator.
450	Brown Hoisting Mach. Co., Cleveland	Roller-bearing idlers, drawings of bridge crane and conveyor installations.
290	Budd Grate Co., Philadelphia	Furnace grates.
75	Buffalo Forge Co., Buffalo	Fans, blowers, exhausters, air coolers, purifiers and preheaters
73	Buffalo Steam Pump Co., Buffalo	Duplex and centrifugal pumps.
277	Builders Iron Foundry, Providence	Venturi meters, venturi nozzles for 1 000 lb. pressure, boiler-load indicator, venturi ammonia meter, planimeter for totaling meter charts.
8	Bundy Steam Trap Co., Nashua, N. H	Steam traps.
A-Main Fl.	Burhorn, Edwin, Co., New York	Cooling towers.
448	Carbondale Grate Bar Co., Scranton, Pa	Furnace grates.
22	Carborundum Co., Perth Amboy, N. J	Carborundum refractories and carboplastic gun and cement.
285	Carr Fastener Co., Cambridge, Mass	"Dot" high-pressure lubricating system.
264	Carrick Engineering Co., Chicago	Automatic combustion-control equipment.
17	Carling Turbine Blower Co., Worcester, Mass	Small steam turbines and turbine blowers.
73	Carrier Air Conditioning Co. of America, Buffalo	Air-conditioning equipment.
34	Carrier Engineering Corp., Newark, N. J	Air-conditioning equipment.
440	Campbell, Andrew C., Inc., Bridgeport, Conn	Nibbling machines.
276	Cash, A. W. Co., Decatur, Ill.	Craig system of automatic combustion control, pressure reducing and regulating valves.
568	Cashin, W. D. Co., Boston	"Thermoflex" thermostats, return traps, and low-pressure boiler feeder.
14	Celite Products Co., Los Angeles	"Sil-O-Cel" insulating brick and blocks "Celcote" boiler coating and high temperature cements.
564-565	Centrifix Corp., Cleveland	Centrifugal steam purifiers.
2	Chapman Valve Mfg. Co., Indian Orchard, Mass	Valves for high and low pressures, motor-operated valves.
92	Cleveland Worm & Gear Co., Cleveland	Worm-gear speed-reduction units.
337	Clipper Belt Lacer Co., Grand Rapids, Mich	Steel belt lacing and belt cutters.
15-B	Coen Company, Inc., San Francisco	Mechanical and steam atomizing oil burners, oil heaters and strainers.
67	Cochrane Corp., Philadelphia	V. notch meters and recorders, multi-port back-pressure valves, steam traps and separators.

EXHIBITORS AT THE POWER SHOW AND THEIR PRODUCTS—Continued

Booth No.	Manufacturer	Product
482	Coffin Valve Co., Boston	Units for electrically operating different types of valves and sluices.
532	Cooling Tower Co., New York	Atmospheric water cooling towers spray-cooling equipments, air washers.
24	Combustion Engineering Co., N.Y.	Lopulco and unit pulverized-fuel systems, fin furnace, air preheater and mechanical stokers.
531	Combustion Pub. Corp., N.Y.	
92	Connelly, D., Boiler Co., Cleveland	Water-tube boilers.
346-347	Connor, Wm. B., Inc., New York	Steam traps and specialties.
43	Connery & Co., Inc., Philadelphia	Expansion stiffeners for breechings, air ducts, etc., air-cooled dampers and preheaters.
328	Continental Valve & Equipment Co., Framingham, Mass.	Forged-steel fittings, reducing valves and pump governors.
60	Consolidated Safety Valve Co., New York	Pressure gages, "Consolidated" safety valves, Hancock globe and angle valves.
454	Consolidation Coal Co., New York	Samples of coal and illustrations of mining operations.
420	Cork Foundation Co., New York	Cork blocks for absorbing vibrations between machines and foundations.
241-242	Cory, Chas. & Son, Inc., New York	Valve-control equipment, signal systems, interlocks, meters and indicators
52	Crane Co., Chicago	Motor-operated valves, emergency stop valves, steel gate valves, globe, check, safety and relief valves
209	Crane Packing Co., Chicago	Extended funnel ferrule for condensers, metallic condenser-tube packing
402-403	Crankless Engine Co., Inc., New York	Crankless oil engine
302-303	Crosby Steam Gage & Valve Co., Boston	Gages, safety, blowoff and relief valves
16	Cutler-Hammer Mfg. Co., Milwaukee	Valve control and automatic motor controllers
248	Dampney Co. of America, Boston	Coatings for metal surfaces and apparatus for applying it
36-37	Davidson, M.T., Co., New York	Simplex steam pump and centrifugal pumps
494	Davis, G. M., Regulator Co., Chicago	Reducing valves, back-pressure valves, stop and check valve, steam traps
561	Davis Engineering Corp., New York	Traps and other specialties
13	Dearborn Chemical Co., Chicago	Feed-water treatment, lubricating oils and greases
536-543	De Laval Separator Co., New York	Centrifugal oil purifiers
536	De Laval Steam Turbine Co., Trenton, N. J.	Worm-gear reduction units, helical gears, centrifugal pumps, steam turbines and centrifugal compressors
204-5-6	Detroit Stoker Co., Detroit	Multiple-retort underfeed stokers
10	D'Este, Julian, Co., Boston	"Curtis" damper regulators, reducing valves, traps and temperature regulators
503	Detroit Twist Drill Co., Detroit	Machine tools
94	Detrick, M.H., Co., Chicago	Detrick, sectional supported side walls and flat suspended arch
16	Diamond Power Specialty Co., Detroit	Electrically operated valve-in-head blower systems, mechanical soot blowers, and protection barriers
232	Dickson, Walter S. & Co., New York	Ventilating and heating apparatus
215	Dixon Joseph Crucible Co., Jersey City, N. J.	Graphite greases, "Silica" graphite paints and primers, spring oil and rust solvent
209A	Dodd, Mead & Co., Inc., New York	
27	Dodge, F. W., Corp., New York	Sweet's engineering catalog
407	Donnelly Systems Co., New York	Steam control and distribution equipment
41	Drake Non-Clinkering Furnace Blk. Co., New York	Furnace blocks, furnace-door safety latches
500-501	Durabla Mfg., Co., New York	Packing, paints and valve disks
288-289	Edge Moor Iron Co., Edge Moor, Del.	Drawings and photographs illustrating single-pass boiler, horizontal and cross-drum boilers
30	Edward Valve & Mfg. Co., East Chicago, Ind.	High-pressure motor-operated valves non-return and blowoff valves.
271-272-273-274	Elliott Co., Jeanette, Pa.	Small steam turbine, single-and two stage-ejectors, automatic non-return valves, strainers and blowoff valves.
44-B	Ellison, Lewis M., Chicago	"Ellison-Leach", CO_2 analyzer inclined and vertical draft gages
18	Engineer Co., The, New York	"Turner baffle walls, combustion control, "Enco" oil burners
314	Engineering Magazine Co., New York	
417	Engelhard Charles, Inc., New York	Electrical measuring instrument for temperatures and CO_2
28-B	Engineers Book Shop, New York	Technical books
217-218	Erie City Iron Works, Erie, Pa.	Unit coal-pulverizing system
461	Erie Malleable Iron Co. (Kondu Div.), Erie, Pa.	Valves and fittings
72	Ernst & Co., Newark, N. J.	Inclined boiler gages
100-101	Everlasting Valve Co., Jersey City, N. J.	Everlasting and flat-plug valves, gate valves and tandem blow-off valves
442	Excello Tool & Mfg. Co., Detroit	Bushings, grinding spindles and other products
570	Fabian, Goodman S., New York	
246	Fafnir Bearing Co., New Britain, Conn.	Industrial ball bearings
326-327-330-331	Fairbanks Morse & Co., New York	Ball-bearing centrifugal pumps electric motors and Diesel engines
338-339	Falk Corporation, The, Milwaukee	Herringbone gear speed-reduction units, "Falk-Bibby" flexible coupling
17	Falls Engine Works, Sheboygan, Wis.	Automatic engine stops
544	Federal Gauge Co., New York	Gages, steam specialties
35	Fisher Governor Co., Marshalltown, Iowa	Pump governors, pressure regulators, reducing valves and steam traps
315	Flexible Steel Lacing Co., Chicago	"Alligator" steel-belt lacing, "Flexco" belt fasteners and lamp guards
408	Flexitallic Gasket Co., Camden, N. J.	"Flexitallic" gaskets
556	Foote Bros. Gear & Mch. Co., Chicago	Vertical worm and spur-gear reducer and standard worm-gear reduction units
84	Foster Engineering Co., Newark, N. J.	Pressure regulators, pump governors, non-return, back-pressure and relief valves, liquid-level gages
62	Foxboro Co., Inc., Foxboro, Mass.	Indicating and recording gages and thermometers, liquid level gages
46	Flynn & Emrich Co., Baltimore	"Huber" hand stokers and mechanical stokers
465	Frederick Iron & Steel Co., Frederick, Md.	Centrifugal pumps, rubber-bushed flexible couplings
14-a&14-b	Fuller-Lehigh Co., Fullerton, Pa.	"Fuller" coal-pulverizing, transporting and burning equipment, "Fuller-Bonnot" unit mill, waste-heat coal driers, automatic bin-level indicators.
252-253	Fulton Co., The, Knoxville, Tenn.	"Sylphon" pressure reducing valves, interlocking valves for fuel-oil systems, damper and temperature regulators.
214	Furnace Engineering Co., New York	"Simplex" unit-type coal pulverizer
15-a	G. & G. Atlas Systems, New York	"Atlas" pneumatic tube systems
505	Garlock Packing Co., Palmyra, N. Y.	Asbestos and metallic packings
4-5	General Electric Co., Schenectady	Motors and motor controls, surface air cooler and flow meters
498	General Refractories Co., New York	Chrome and magnesite refractories and fireclay silica in standard and special shapes
232	Gibby Engineering Co., East Boston, Mass.	Hand stokers
87-88	Gillis & Geoghegan, New York	Telescopic hoists and for ash removal
258	Girtanner Engineering Corp., New York	Steam-jet and hydraulic ash conveyors, soot and fly-dust removal systems
92	Gordon, Jas. T., Co., New York	"Nicholson" steam traps, strainers, vacuum pumps and reduction gears
201-2-3	Green, A. P., Fire Brick Co., Mexico, Mo.	Firebrick and refractories
49	Griscom-Russell Co., New York	"Reilly evaporators" U-fin generator air coolers, G-R bent-tube evaporator and oil cooler
21	Hagan Corp., Pittsburgh	Combustion-control apparatus, deconcentrators and steam purifiers
404-405	Hahn Engineering Co., Philadelphia	Steam-jet conveyors and sectional cast-iron storage tank "Huber" hand stokers
46	Hand Stoker Corp., New York	"Huber" hand stokers
557	Hanson-Whitney & Co., Hartford, Conn.	Drill presses and milling machines
60	Hancock Inspirator Co., New York	Gages, valves and steam specialties
427	Hanson & Yorke Co., New York	
329	Hardinge Co., Inc., New York	Coal-drying, pulverizing and classifying equipment, rotor spray for gas scrubbing and air conditioning
60	Hayden & Derby Mfg. Co., New York	Injectors
81-82	Hays, Jos. W., Corp., Michigan City, Ind.	CO_2 recorders and draft gages
496-497	Heine Boiler Co., New York	Water-tube V-type and cross-drum boilers
471	Hendrick Mfg. Co., Carbondale, Pa.	Perforated metal screens, interlocked steel grating and stair treads

EXHIBITORS AT THE POWER SHOW AND THEIR PRODUCTS—Continued

Booth No.	Manufacturer	Product
510	Hill, Dr. E., Vernon Co., Chicago	Pitot tubes, manometers, draft gages and anemometers
10	H. & O. Chain Co., So. Norwalk, Conn.	Transmission chains
502	Hofft, W. A., Co., Indianapolis	Stokers and furnace arches
428	Homestead Valve Mfg. Co., Homestead, Pa.	Quarter-turn valves, globe and blowoff valves
81-82	Huyette, Paul B., Co., Philadelphia	Draft and CO_2 recorders, steam-flow meters, safety water columns. Damper regulator and flue cleaners
551	Hydraulic Press Mfg. Co., Mount Gilead, Ohio	Drop-forged valves and fittings
572-573	Hyatt Roller Bearing Co., Newark, N. J.	Roller bearings
533	Ilg Electric Ventilating Co., Chicago	Fans, motors, and ventilating equipment
233	Illinois Engineering Co., Chicago	Steam traps and specialties
410	Imperial Coal Co., New York	
39	Industrial Power, Chicago	
314	Industrial Management Group, New York	
221	International Filter Co., Chicago	Water filters and purifiers
437	Insulating Products Corp., New York	Insulating materials
9	International Nickel Co., New York	Commercial forms of monel metal in rods, castings and sheets
444	International Trade Press, Inc., New York	
438-439	Irving Iron Works Co., Long Island City, N. Y.	Irving "subway" open steel flooring and "vizabledg" soft-step for stairs and ladders
12-A	Instant Water Heater Co., N. Manchester, Ind.	Water heaters
90	Jenkins Bros., New York	Iron, bronze and steel valves; blowoff valves, automatic stop and check valves, pump valves and sheet packings
508-509	Johns-Manville, Inc., New York	Asbestos insulating materials
549	Jones, W. A., Foundry & Mch. Co., Chicago	Worm- and spur-gear speed reducers
449	Justus Steam Trap Co., Napanoch, N. Y.	"Justus" steam traps
228	Keating Pipe Bending & Supply Co., New York	
211	Keeler E. Co., Williamsport, Pa.	Water-tube boilers
72	Kellogg, M. W., Co., New York	Pipe, valves and fittings
316	Key Boiler Equipment, Co., E. St. Louis, Ill.	"Key" safety handhole plates and caps
8-a	Keystone Lubricating Co., Philadelphia	"Keystone" safety lubricating systems, lubricants and greases
11	Keystone Refractories Co., New York	Dura-stix bonding mortar and granular refractories
480	Kieley & Mueller, Inc., New York	Steam traps, reducing valves back-pressure valves
95	King Refractories Co., Buffalo	"Mono" boiler baffles and furnace cements
424	Kingsford Fdry. & Mch. Co., New York	Sectional water-tube boilers
19	Kissick-Fenno Co., Philadelphia	Soot cleaners and feed-water regulators
453	Kittredge, John W., Atlanta, Ga.	Two-speed chain hoists
451	Kitts Steam Specialty Co., Oswego, N. Y.	Steam traps and pressure regulators
317	Klingerit, Inc., New York	Valves, packings and gage glasses
Mez. fl.	Knickerbocker Photo Service, New York	
91	Ladd, George T. Co., Pittsburgh	Water-tube boilers
271	Lagonda Mfg. Co., Springfield, O.	Non-return valves and tube cleaners
86	Lead Lined Iron Pipe Co., Wakefield, Mass.	Lead-and tin-lined iron pipe, valves, fittings and stop cocks
272	Liberty Mfg. Co., Pittsburgh	Boiler-tube cleaners
435	Liberty Electric Corp., Stamford, Conn.	"Liberty" valve operators
416	Libbey Glass Mfg. Co., Toledo, O.	Standard and high-pressure gage glasses
201	Liptak Fire Brick Arch Co., Chicago	"Liptak" single- and double-suspension arches and furnace blocks
307	Locke Regulator Co., Salem, Mass.	Reducing valves, damper regulators, engine-stop and speed-limit systems
516	Ludeman Bros. Inc., New York	Safety stops for engines, turbines and pressure lines
63	Lunkenheimer Co., Cincinnati	Cast-steel electrically operated gate valves, all Monel valves for 400 lb. pressure and 750-deg. temperature, check and blowoff valves
449	McDonald & Co., New York	"Justus" steam traps
13	McLeod & Henry Co., Troy, N. Y.	Suspended boiler arches, steel mixture veneer lining for furnace walls
323	McVicker, W. B., Co., Brooklyn	Boiler compound
562	Manistee Iron Works Co., Manistee, Mich.	Single and multi-stage centrifugal pump, Rees Turbo centrifugal pumps
60	Manning, Maxwell & Moore, Inc., New York	"Ashcroft" gages "Consolidated" safety valves "Reeves" variable-speed transmission
40	Manufacturers Record, Baltimore	
343	Marlin-Rockwell Corp., Jamestown, N. Y.	Gurney ball bearings
210	Marion Mch. Fdry. & Supply Co., Marion, Ind.	Stokers, soot blowers, and water heaters
223-224	Mason Regulator Co., Boston	Reducing valves, pump governors, hydraulic damper regulator, cast-steel valves
267	Merco Nordstrom Valve Co., New York	Lubricated valves for blowoff, feed-water lines, etc.
31	Merritt, L. R. & Co., New York	Boilers, engines and blowers
237-238-239-240	Merrick Scale Mfg. Co., Passaic, N. J.	Conveyor weightometer
477-478	Metropolitan Brass Founders Ass'n, Brooklyn	
408	Metallistic, Inc., Jersey City, N.J.	Plastic metallic packings
268	Midwest Piping & Supply Co., St. Louis	"Midwest" pipe joints and steam specialties
"A" Mez. fl.	Mixing Equipment Co., New York	
262-263	Morse Chain Co., Ithaca, N. Y.	Silent chain drives
433	Moore Steam Turbine Corp., Wellsville, N. Y.	Steam turbines, single-and multi-stage centrifugal pumps
300-301-304-305	Morse Dry Dock & Repair Co., Brooklyn	Fuel-oil burners
254	Moto Meter Co., Inc., L. I. City, N. Y.	"Motoco" industrial thermometers
554-555	Mueller Brass Co., Port Huron, Mich.	Copper and brass rod, tubing, forgings and castings
79	Murphy Iron Works, Detroit	Mechanical Stokers
566	Murray Conduit Systems, New York	Murray conduits
66	Nash Engineering Co., S. Norwalk, Conn.	Compressors, pumps and return-line systems
83	National Assn. of Stationary Engineers	
82-83	National Engineer, Chicago	
76	National Co., Boston	Water-column illuminators
517	National Lead Co., New York	Babbitt metals and cinch bolts
521	National Acme Co., Cleveland	Automatic screw machines
8-b	National Tube Co., Pittsburgh	Seamless tubing and pipe
447	Naugatuck Mfg. Co., Naugatuck, Conn.	Seamless copper ball floats
93	Neemes Foundry Inc., Troy, N. Y.	Shaking and dumping furnace grates
92	Nicholson, W. H. & Co., Wilkes Barre, Pa.	Piston-operated steam traps
526-527-528-529	Niles-Bement-Pond Co., New York	Gears and speed-reduction units
484	Nitrose Co., The, Peoria, Ill.	Protective paint for metal surfaces
279-280	Norma-Hoffman Bearings Corp., Stamford, Conn.	"Norma" ball bearings and "Hoffman" roller and ball bearings
19	Northern Equipment Co., Erie, Pa.	"Copes" feed-water regulators, pump governors and valve-movement indicators
324-325	Norton Co., Worcester, Mass.	Furnace refractories and cements, including air-cooled "Crystalon" furnace blocks, special hearth tile, baffle bricks, alundum enameling muffle
342	Nice Ball Bearing Co., Nicetown, Pa.	Ball bearings
260	Obermayer, S., Co., Chicago	Refractory materials
227	Olsen Tinius, Testing Mch. Co., Philadelphia	Hydraulic Brinell hardness-testing machines, static dynamic balancing machines
57	Otis Elevator Co., New York	Commercial steel castings
401	Peerless Machine Co., Racine, Wisc.	Power hacksaw
47	Peabody Engineering Corp., New York	"Peabody" fuel-oil-burning equipment
286-287	Pennsylvania Crusher Co., Philadelphia	Coal crushers and conveyors
258	Perfection Grate & Supply Co., Springfield, Mass.	Furnace grates
3 & 28-a	Permutit Company, The, New York	Water-softening and filtering equipment, "Ranarex" CO_2 recorder
451	Pitts & Kitts Mfg. & Supply Co., New York	Steam specialties
4	Pittsburgh Valve Fdry. & Const. Co., Pittsburgh	Motor- and cylinder-operated gate valves, high-pressure valves and fittings
10	Philadelphia Gear Works, Philadelphia	Industrial gears and silent chain drives
91	Pittsburgh Testing Laboratory, Pittsburgh	Laboratory equipment and testing methods
93	Plibrico Jointless Fire Brick Co., Chicago	Monolithic furnace lining

EXHIBITORS AT THE POWER SHOW AND THEIR PRODUCTS—Continued

Booth No.	Manufacturer	Product
495	Powell, Wm. Co., Cincinnati	Valves and steam specialties
42	*Power*, New York	
98	Power Plant Engineering, Chicago	
20	Power Specialty Co., New York	"Foster" superheaters and economizers
219-220	Preferred Utilities, Co., New York	"Ray" rotary fuel-oil burner
48	Pratt & Cady Co., Bridgeport, Conn	High- and low-pressure globe and gate valves
528-529	Pratt & Whitney, New York	Machine tools
452	Production Machine Co., Greenfield, Mass.	
462-463	Public Service Production Co., Newark, N. J.	
306	Pyramid Iron Products Co., New York	"Pyramid" grates
569	Queen's Run Refractories Co., Lock Haven, Pa	Firebrick and refractories
89	Quigley Furnace Specialties Co., New York	Hytempite refractory material, insulating brick, acid-proof cement and refractory gun
3	Racine Tool & Mch. Co., Racine, Wisc	High-speed metal-cutting machine
292-293	Ramsey Chain Co., Inc., Albany, N. Y.	"Ramsey" silent chain drives
24	Raymond Bros. Impact & Pulv. Co., Chicago	Coal-pulverizing equipment
48	Reading Steel Casting Co., Bridgeport, Conn	Valves, fittings, and specialties
415	Ren Mfg. Co., Winchester, Mass.	Lamp locks and electrical specialties
6	Republic Flow Meters Co., Chicago	Meter for steam, air and gas, CO_2 recorders, pyrometers, liquid level indicators and coal meters
81	Reliance Gauge Column Co., Cleveland	Safety water columns, copper and nickel electric deposited metal floats
60-a	Reeves Pulley Co., Columbus, Ind.	"Reeves" variable-speed transmission
283-284	Richardson Scale Co., Passaic, N. J.	Apron-feed coal scales and hand weighing larry
79	Riley Stoker Corp., Worcester, Mass.	Unit coal pulverizer and underfeed mechanical stokers
548	Roberts Steam Specialty Co., Cleveland	Laminated steel floats, water columns and water-gage illuminators
278	Robinson, John R., New York	Pipe gaskets
11-a	Roto Company, The, Hartford, Conn	Tube cleaners
409	Rollway Bearing Co., Inc., Syracuse, N. Y	Shaft bearings
559-560	Ruggles Klingeman Mfg. Co., Salem, Mass	Pump governors, temperature-control regulators, damper regulators, exhaust relief and reducing valves
329	Ruggles Coles Engineering Co., New York	Drying equipment for coal and other materials
491	Ruths Accumulator Co., Inc., New York	"Ruths" steam accumulator
318	"S-C" Regulator Mfg. Co., Fostoria, Ohio	S-C feed-water regulators and drainage control
332-333	S.K.F. Industries, Inc., New York	S.K.F. ball bearings and shaft hangers
33	Sarco Co., Inc., New York	"Sarco" steam traps
545-546	Schutte & Koerting Co., Philadelphia	Multi-jet condenser, sectional oil cooler, toggle top stop, check valve and radian fin generator air cooler
432	Scandia Mfg. Co., Newark, N. J.	
69	Scoville Mfg. Co., Waterbury, Conn	Admiralty condenser tubing, brass rod, sheet, and tubing
256-257	Seminole Chemical Co., Inc., New York	Method of cleaning boilers
26	Sharples Specialty Co., Philadelphia	Centrifugal oil purifiers
76	Simplex Valve & Meter Co., Philadelphia	Indicating and recording boiler-feed meters, indicating manometers
"C"	Skeen, D. H. & Co., Chicago	"Mercon" pressure regulators
321-322	Skinner Bros. Mfg. Co., Elizabeth, N. J.	Steam coil heaters, oil-fired heaters, revolving siphon ventilator
431	Skinner, M. B. Co., Chicago	Valve-reseating tool and pipe-line clamp
492	Simplex Oil Heating Co., Providence, R. I.	Industrial oil burners, blowers and pumping units
245	Sherwood Mfg. Co., Buffalo	Lubricators and injectors
473	Shaw, Benj. F. Co., Wilmington, Del	
281-282	Smidth, F. L. & Co., New York	"Lonix" belt drives
85	Smith & Serrell, Newark, N. J.	"Francke" flexible couplings and graphited bronze bushings
418-419	Smoot Engineering Corp., New York	"Smoot" combustion control, pressure regulators and generator air coolers, safety controller
17	Smith Gas Engineering Co., Dayton, Ohio	Gas producers
469	Spray Engineering Co., Boston	Air filters and washers, strainers, flow meters and spray nozzles
10	Southern Engineer, The, Atlanta, Ga	
76	Sowden, W. K., New York	Gages, inclined water columns and water-column illuminators
443	Speednut Wrench Corp., New York	Wrenches
28	Spense, Paulsen, Co., New York	"Sterling" boiler-feed system, steam traps, reducing valves, draft regulators and shaft couplings
31-32	Springfield Boiler Co., Springfield, Ill	Water-tube boilers
312	Stack Heater Co., Boston	Feedwater heaters
26	Stewart-Sayers Co., New York	"Northwestern" boiler-damper controls, "Benz" Diesel engines
28	Standard Water Systems, Hampton, N. J.	Evaporators and heaters
336	Standard Steel & Bearings, Inc., Plainville, Conn	Ball bearings
28	Sterling Engr. & Equipment Co., Hyde Park, Mass.	Sterling boiler-feed systems, lifting and separating traps
518	Sterling Engine Co., Buffalo	Gasoline engines for industrial uses
76	Stets Co., Boston	Stets feed water regulator
329	Steacy-Schmidt Co., York, Pa.	Steam specialties
534	Strom Ball Bearing Mfg. Co., Chicago	Radial and annular thrust ball bearings
407	Strong-Scott Mfg. Co., Minneapolis	"Unipulvo" unit coal pulverizer
411-412-413-414	Sturtevant, B. F. Co., Hyde Park, Mass.	Lead-coated steel tube economizer, air preheater, fans and blowers for forced draft, small turbines and stokers
427	Sumet Corp., Buffalo	"Sumet" metal bearing castings
56	Superheater Co., The, New York	"Elesco" superheaters
229-230	Swartwout Co., Cleveland	Steam and oil separators and traps, exhaust heads, feedwater heaters and return traps
27	Sweets Engineering Catalog, New York	"Sweets" engineering catalog
575	Sweet & Doyle Fdy. & Machine Co., Troy, N. Y	Steam traps
59	Tagliabue, C. J. Mfg. Co., Brooklyn	Recording thermometers, dial industry thermometers, controller for temperature and pressure, hydrometers and viscosmeters
507	Taylor Instrument Co., Rochester, N. Y	Indicating and recording thermometers, mercury-column vacuum and pressure gages, barometers
265-266	Techno Service Corp., New York	"Borsig" valves and pump for sludge and ash handling
421-422	Terry Steam Turbine Co., Hartford, Conn	Steam turbines, reduction gears and flexible couplings
504	Templeton-Kenly Co., Ltd., Chicago	Simplex jacks
28	Templeton Mfg. Co., Hyde Park, Mass.	Steam traps
222	Thomas Flexible Coupling Co., Warren, Pa	Flexible shaft couplings
95-a	Tide Water Oil Sales Corp., New York	Oils and greases
467	Timken Roller Bearing Co., Canton, Ohio	Roller bearings
499	Toledo Pipe Threading Mch. Co., Toledo, Ohio	Pipe-threading machines
503-504	Topping Bros., New York	Tools, supplies and accessories
503	Torchweld Equipment Co., Chicago	Welding apparatus
472	Trane Co., The, La Crosse, Wisc.	Bellows packless radiator valves, steam trap and vacuum pumps
429	Trill Indicator Co., Corry, Pa.	Open and closed type continuous card indicators, spring indicators, reducing wheels and flushometer
441-442	Triplex Machine Tool Co., New York	Milling, grinding and nibbling machines
213	Tioga Steel & Iron Co., New York	Forged steel valves
45	Uehling Instrument Co., Paterson, N. J.	CO and CO_2 recorders, combined barometer and vacuum recorders, waste meters and pyros-porous gas filter
572	Unishear Co., Inc., The, New York	
519	Union Iron Works, Erie, Pa.	Water-tube boilers
520	Vastine Sales Corp., Chicago	Furnace-door observer
17	Vincent-Gilson Engineering Co., New York	Soot cleaners and turbine blowers
269-270	Vogt Henry Machine Co., Louisville, Ky	Drop-forged steel valves and fittings
406	Vulcan Radiator Co., Hartford, Conn	Extended surface tubing for radiators, heaters and condensers

EXHIBITORS AT THE POWER SHOW AND THEIR PRODUCTS—Concluded

Booth No.	Manufacturer	Product
19	Vulcan Soot Cleaner Co., Du Bois, Pa	Soot blowers
261-262	Wailes Dove-Hermiston Corp., New York	Paints and enamels for metal surfaces
255	Waite & Davey Co., Inc., Long Island City, N. Y.	Air-cooled furnace arches and blocks
250-251	Walsh & Weidner Boiler Co., Chattonooga, Tenn	Water-tube boilers
308-309-310-311-& 44-a	Walworth Co., Boston, Mass.	Valves, fittings and specialties
231	Warren Steam Pump Co., Warren, Mass.	Single- and multi-stage centrifugal pumps, duplex oumps and air separators
225-226	Warren Webster & Co., Camden, N. J.	Modulation system of steam heating, packless valves, heaters, boiler return and vent traps
309	Watts Regulator Co., Lawrence, Mass.	Feed-water regulators, damper and pressure regulators, pump governors
99	Wayne Tank & Pump Co., Fort Wayne, Ind.	Oil handling, storage and dispensing system, water-softening equipment
487-488-489-490	Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.	Small steam turbines, air ejectors, circuit breakers, measuring instruments, micarta plates, tubing and gears
506	Weston Electric Instrument Co., Newark, N. J.	Electrical measuring instruments
64	Wheeler Condenser & Engr. Co., Carteret, N. J.	Condensers, evaporators, cooling towers, steam-jet air pumps
77	Wheeler, C. H. Mfg. Co., Philadelphia, Pa.	Radojet air pumps, Radojet augmenter, "Froude" absorption dynamometer
557	Whitney Mfg. Co., Hartford, Conn.	Silent and roller chain drives
479	Wickes Boiler Co., Saginaw, Mich.	Water-tube boilers
493	Williams, D. T. Valve Co., Cincinnati, Ohio	Bronze and iron gate valves, oil cups, lubricators and other specialties
291	Williams Gauge Co., Pittsburgh, Pa	Gages, water columns and steam trap
485-486	Wilson Welder & Metals Co., Hoboken, N. J.	Gasoline-engine-driven electric welding machine
61	Wing, L. J. Mfg. Co., New York	Turbo- and motor-driven blowers, unit heaters and exhausters
442	Wisconsin Electric Co., Racine, Wisc.	Motor-driven portable grinders
474	Wood's, T. B. Sons Co., Chambersburg, Pa	Shaft collars, hangers, pillow blocks and flexible couplings and belt contractor
511-12-13	Worthington Pump & Mch. Corp., New York	Centrifugal pumps, air compressors, duplex and triplex pumps
236	Wright-Austin Co., Detroit, Mich.	Separators, trap and water columns
259	"X" Laboratories, New York	"X" Liquid for repairing leaks in boilers
7a 7b	Yarnall-Waring Co., Philadelphia, Pa	Motor-operated blowoff valves, V-notch meters, spray heads and steam traps.
425-426	Yale & Towne Mfg. Co., Stamford, Conn.	Chain hoists

A New German Central Station*

The Rummelsburg Station, near Berlin, Will Have an Ultimate Capacity Above 500,000 Kw.

BY PROF. G. KLINGENBERG

THE City of Berlin is now building a municipal generating station on the bank of the Spree River at Rummelsburg, which will have an ultimate rating between 500,000 and 600,000 kw. The first section will include sixteen 18,820-sq.ft. boilers fired by pulverized coal, three 70,000 twin-tandem compound turbines, and three 10,000-kw. bleeder turbines for stage feed-water heating. Some details in the design are discussed briefly herein.

STEAM TEMPERATURE AND PRESSURE

Until recently steam temperatures above 670 deg. F. at the turbine throttle were considered extreme. Better blade material and lower steam velocities have advanced the safe limit to 750 deg. F. and will permit even slightly higher temperatures.

The maximum practical steam pressure at this temperature is about 515 lb. per sq.in. Without reheating this will result in a moisture content of 10 to 15 per cent in the low-temperature turbine stages, which is not objectionable when low steam velocities are employed. The latter feature is particularly important, since it lessens the danger due to moisture. Recent stream-line studies in turbines have also resulted in material improvement in their Rankine efficiency.

It is an open question whether the maximum pressure should be adopted in each instance, as this decision should be based on individual economic conditions. It may be said, however, that the higher the capacity and the load factor of a plant, the greater will be the thermal gain due to high pressure, and this may easily exceed the fixed charges on the required additional investment.

Consideration of all factors shows that a pressure of 515 lb. for the Rummelsburg Station is feasible, as it does not involve excessive cost for materials or a radical change in piping construction.

INTERSTAGE REHEATING

Although the thermal gain by reheating has been fully recognized in Germany, considerable doubt exists as to its economic advantage, in view of the costly equipment, the complications in supervision and the maintenance expense. The pioneer work by American engineers is being followed with great interest and may lead to its adoption at a later date.

HEATING FEED WATER WITH BLEEDER STEAM

The greater thermal efficiency obtained by this modern method is unchallenged. The former practice of bleeding turbines at three or four points has, however, given way to not more than two bleeder connections, resulting in greater simplicity.

For very large turbine installations, where continuity of operation is paramount, the main units should preferably not be tapped for heating feed water. Instead, this work should be done by auxiliary extraction turbines operating at about 3,000 r.p.m., which will not add materially to the cost per installed kilowatt of the plant.

At Rummelsburg these smaller turbines form a separate group which is housed together with the evaporators and feed pumps in an addition to the boiler house.

On first consideration it may appear that many advantages of stage heating by the main units have been sacrificed, particularly in regard to the larger quantity of steam in the lower stages, which necessitates larger condensers and longer turbine blades. If, however, the performance of an 80,000-kw. bleeder

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turbine is compared with that of a 70,000-kw. turbine and a 10,000-kw. bleeder turbine, the latter plan will prove superior, particularly in view of the fact that in either case two low-pressure rotors are necessary for such large units, permitting the use of sufficiently short blading. Greater operating reliability is obtained and the arrangement of the condensing equipment is simplified. The condenser room contains only the main condensers, the turbine air cooler and the short high-pressure steam piping. A large amount of space is gained, which lessens the building cost materially.

The bleeder units are used as house turbines, but inasmuch as their capacity exceeds the demand, they also supply current to the main busbars. Automatic switching apparatus immediately disconnects them for house service only in case the bus voltage drops below a predetermined point.

The condenser circulating, air, and condensate pumps are located in the water screen house, which eliminates costly condenser intake and outlet tunnels beneath the turbine room building.

Boiler House

Compactness combined with accessibility is obtained by the arrangement of the steel encased boilers, with flue-gas air preheaters and feed-water heaters, in inclosed units with short flue connections. This permits the use of comparatively low buildings and effects a saving in cost.

Pulverized-Coal Firing

American practice, which utilizes boilers of standard construction, with a suitably designed furnace, is generally followed in Germany. It is highly probable that new boilers in which the heating surface completely surrounds the combustion space will shortly be developed for pulverized-coal firing. Lower furnace volumes will doubtless follow.

Pulverized coal is of particular advantage to Germany as it permits full operation with low quality and various kinds of coal.

The large moisture content of German coals, often as high as 20 per cent, makes it practically impossible to pulverize the coal without drying. The familiar American rotary kiln drier will doubtless be displaced by other types in Germany.

The character of German coals makes it inadvisable to utilize the flue gas for drying. In its stead the practice of doing this work with exhaust or low-pressure steam, as exemplified in the brown-coal districts is gaining favor. This results in a simple, cheap drier that needs little attention.

At Rummelsburg steam for drying is obtained at about 30 lb. per sq.in. from the bleeder turbines, and is controlled by manipulating a valve. The condensate is returned to the boilers. The driers are directly under the bunkers, which permits a gravity feed.

There is still considerable difference of opinion concerning the best type of mill. The tube mill has found some favor, particularly for pulverizing hard gas-house coke

Gasification and low-temperature carbonization of coal, in order to obtain valuable by-products, is receiving earnest attention in Germany. Complete gasification of the fuel is not likely to make much headway, so far as central stations are concerned. The second method is more promising, as the coke can be pulverized and burned under the boilers, while the tar and other byproducts may be sold for industrial purposes. In the future coke plants may be erected in the brown-coal districts, to supply coke to power plants that have their own pulverizing equipment.

Principal Equipment at Rummelsburg Station

There are sixteen vertical water-tube boilers, each containing 17,216 sq.ft. of heating surface and 1,614 sq.ft. of water-cooled furnace walls. Normal steam output of each boiler will be 143,000 lb. per hour with a maximum output of 169,400 lb. per hour. Feed water is heated to 194 deg. F. with bleeder steam. Air for combustion is preheated to 302 deg. F. Each boiler house occupies an area of 30,789 sq.ft., giving a ratio of 29.5 sq.ft. for each thousand pounds of steam generated at rating. The total volume of the boiler house and additions is 2,677,557 cu.ft.

The main steam turbines consist of three 70,000-kw. twin-tandem compound turbines, each machine being divided into two 35,000-kw. sections. One generator is driven by the high- and intermediate-pressure wheels and the other by two parallel-flow low-pressure wheels. Both sections operate at 1,500 r.p.m. The working pressure at the throttle is 477 lb. per sq.in., with a total steam temperature of 750 deg. F. The steam is expanded to 206 lb. per sq.in. in the high-pressure cylinder and to 34 lb. per sq.in. in the intermediate cylinder, at which pressure it enters the low-pressure turbine section.

The turbine building occupies a ground area of 38,155 sq.ft., giving a ratio of 0.185 sq.ft. per kw. at rating. The volume is 2,729,922 cu.ft.

Six main generators of 44,000-kva. rating generate three-phase, 50-cycle current at 6,000 volts. The voltage is stepped up to 30,000 volts by six 44,000-kva. transformers. Each phase is transmitted in an individual gallery to the switching equipment.

Largest Synchronous Condenser

The largest condenser of the synchronous type ever built was recently put in service on the 220,000-volt transmission system of the Mount Shasta Power Co., of California, partly supplying San Francisco and the surrounding Bay country with electric energy. The condenser, placed in operation for voltage regulation in the high-potential transmission system, has a rating of 40,000 kva. at 0 per cent leading power factor and 25,000 kva. at 0 per cent lagging power factor. It is used, however, with a lagging power-factor characteristic only during periods of starting or light load, during which time the line voltage might rise to an abnormally dangerous point. Under ordinary load conditions a leading current in the condenser is desired to correct for normal voltage drop in the system.

The condenser was built by the Westinghouse Electric & Manufacturing Co. and was placed in operation in the same substation with two other synchronous condensers of a similar design but having ratings of 20,000 kva. each at 0 per cent leading power factor. The new machine will operate at 11,000 volts and has a synchronous running speed of 600 r.p.m.

In Pennsylvania nine thousand tons of coal are transported each day for four and one-half miles by the longest belt conveyor in the world.

Engineering Schools on the Right Track

SMALL salaries generally go hand in hand with mediocre performance. Teachers of engineering, as a class, form an exception to this rule if one may judge from statistical reports recently issued by the committee investigating engineering education under the auspices of the Society for the Promotion of Engineering Education. The investigation is being financed by a grant of funds from the Carnegie Corporation. A comparison of salary data furnished by 2,279 teachers in 75 engineering schools, with similar data sent in by a large number of technical graduates, shows that the average academic salary falls below that of ninety per cent of the graduates in outside work for the first fifteen years after graduation.

For the entire time range covered (up to thirty years after graduation) the total income of the teachers, including their earnings by consultation and other "extra-curriculum" work, averages only about seventy-five per cent of the "median" earnings of graduates in outside work.

Yet the most critical judges—the graduates themselves—express general satisfaction with their engineering education. Less than three per cent of the recent graduates reporting are sorry they studied engineering. Three-quarters of all the graduates find their academic training reasonably well adapted to their practical needs.

This does not mean that there are no suggestions for improvement. The greatest demand is for more instruction in business and economics. Another condition calling for adjustment is the lack of vocational guidance. Just how shall the student enter engineering work? What niche can he fill to best advantage? The rapid shifting from one job to another during the first few years after graduation shows the need for serious study of this problem.

On the whole, the reports of the graduates indicate that engineering faculties are doing a worthy job and working along lines that are substantially correct. The putting into effect of improvements suggested by this survey may safely be left in the hands of those teachers who have brought engineering education to its present state.

Finally, it may not be amiss to point out that good work should be rewarded. It is not unreasonable to hope that those who guide the feet of youth may some day receive compensation on a scale equal to that of practicing engineers of equal age and ability. This, by the way, is not much, as everybody knows.

Freed from financial worries, the engineering teacher of the future would be a still bigger man and throw himself into his work with even greater enthusiasm. Industry, which would benefit most from the improved product, should find some way to pay the bill.

Exchange of Power Between Central Stations and Industrial Plants

MUCH has been written of the advantages of superpower. Guy E. Tripp, in a recent article, specifically designates as one of the advantages of superpower, the fact that such a system can advantageously use power from any economical source within the area covered by it. He takes a steel plant as an example and indicates that power generated from excess blast-furnace and coke-oven gases, could be fed into a superpower system and that the amount of power demanded of the central stations would be appreciably reduced by power supplied from such sources. The philosophy of this idea is sound, and it is physically possible to work out such a scheme.

Many industrial plants where large steam demands exist for heating or process work could develop considerable energy from such steam by the use of high-pressure boilers and reducing turbines. Much of this power would be in excess of the plant requirements. Power from such a source can generally be produced at a low figure when due credit is given to the heat in the exhaust steam when used for industrial purposes. Why have the central stations not availed themselves of this source of cheap power, which could be easily fed into their distribution systems?

Several reasons may be offered for their failure to do so. The central station must have sufficient equipment to meet the peak load demand, which in many systems occurs about six o'clock in the evening. Power is generally not available in any large amount from the industrial plants at that hour, and any service from these plants at other hours would therefore not lessen the capacity or investment in the central station. The industrial power available at off-peak hours would save only a certain amount of coal at the central station and possibly also save some distribution losses. The fixed charges on the interconnecting equipment will tend to lessen this saving. The remainder may not be sufficient to pay fixed charges on additional equipment in the industrial plant and the proportional amount of fuel costs chargeable to power generation, and therefore the plan may not be profitable. On the other hand, an interconnected plant serving much heating in winter might find it desirable to shut down most of its own plant and buy power in summer. This would be desirable for the central station, since its load is low at that time.

Several utilities have such heavy power loads that the peak demand often occurs in the morning. The industrial-plant service under such conditions would effect real savings, both in fuel costs and in investment in central-station capacity.

In still other cases, as at the steel plant, there may be some waste fuel that could be converted into power at all hours. This would form an excellent auxiliary

power to the central station, as it would save both fixed charges and fuel costs. Such plants deserve careful investigation.

While the idea probably does not appeal so much to central stations in large cities with a highly diversified load and where any such industrial plant would be able to supply only an infinitesimal part of the central-station peak, still in a smaller city or town having a few large industries, the capacity to help out might be considerable. Moreover, where there is little diversity in the central-station power load, such a sharing of the reserve investment would tend to lessen the central station's risk as dependent upon business cycles in the principal industry served.

Of course it is essential that the central-station system operator have control of the outside power fed into the system.

A few cases may exist where the central station company, in its zeal to acquire all industrial plant loads, may not give serious consideration to the possibilities of such interconnections, as they might encourage further use of industrial plants.

The idea of such interchange service persists in well-informed engineering circles, and it is to be hoped that the plan will be tried out in many places to test its actual workability. *Power* will be glad to learn of the results of such interconnection.

Where Comprehensive Data Are Needed

IT IS estimated that the water powers of this country are capable of producing about sixty million horsepower for fifty per cent of the time, or thirty-five million for ninety per cent of the time. Using either one of these values as a basis of figuring, gives a yearly output of about two hundred billion kilowatt-hours, or about four times that sold by the central stations in this country last year.

Taking the average cost of this power as delivered to the transmission system at three-quarters of a cent per kilowatt-hour, the water powers of the country have a potential annual value, when completely developed, of one and one-half billion dollars. Nature in her abundance has seen fit to make this great source of power self-perpetuating, therefore it can be expected to be available when other sources have failed, and it makes one wonder why a more intelligent policy cannot be adopted in dealing with water-power developments.

The Federal Water-Power Commission has recently issued its fifth annual report. In this report two things stand out—first, the great activities in water-power development since the enactment of the law under which the Commission was created, and, second, the way the Commission is handicapped in its work owing to the lack of funds and an adequate organization. The latter condition exists, notwithstanding the fact that the Commission can pay all its own expenses from receipts collected under the Federal Water-Power Act, without the necessity of an appropriation from the Federal Treasury. As it is now, these funds go into the Treasury and the Commission has to borrow its personnel from other government departments and has to depend upon the whims of Congress for an appropriation.

In the first five years that the Commission functioned there were filed with it, five hundred and twenty-four applications for water-power developments and one hundred applications for transmission lines. Eliminating duplication, the applications for power development represent an estimated aggregate, for projects that are reasonably certain of construction in the near future, of more than twice the water-power capacity in operation when the Water-Power Act was passed in 1920.

In these projects are involved questions of navigation, irrigation, fish and municipal water supply in addition to power development. Where a number of power developments are on the same river, the problem is further involved since the development of one site may have a detrimental effect on the others if not properly located. It is evident, then, that to pass upon these applications intelligently the Commission must have available a comprehensive study of the rivers on which the developments are to be made. Water-power has now reached a state of progress where we are building for the future as well as the present.

Compressed Air

IN MANY industrial plants compressed air is demanded at a pressure higher than is really required. When air is used for blowing chips, sand and scale in the machine shop, foundry or smithy, it seems a bit absurd to compress it to eighty or a hundred pounds per square inch. Twenty might be an ample pressure.

And how easy it is to try it! A resetting of the compressor governor, perhaps a new spring, and the trick is done. If the users don't know the difference after the first small reduction, cut it down again and continue until the actual limit of usefulness is reached.

The advantages in reduced power and reduced wear and tear at the compressor are obvious. A less conspicuous but no less real advantage is that with lower final pressure the condensation of water vapor will be reduced, perhaps even eliminated.

Portable air-driven tools naturally present another problem. If there are few of them, it may pay to rebuild them with larger cylinders.

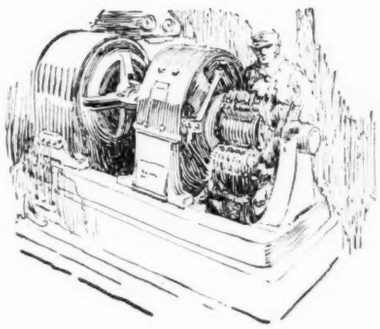
Another saving may be effected in some cases by delivering compressed air at higher temperature than is sometimes customary. The aftercooler reduces the volume of the air in proportion to its absolute temperature. Most devices using air take a definite volume, and the temperature in itself is of no significance. If the air is hotter, it goes farther for exactly the same work of driving the compressor. In air engine work heaters are sometimes used, bringing the air to a high temperature before it enters the engine. This increases its volume, perhaps doubling it, and its energy, or work capacity, in the same ratio. It also reduces the tendency to ice formation in the exhaust ports. Very hot air would be unsuitable for hand tools and hoses, but in most cases cooling is certainly in the wrong direction.

There are two objects that justify the aftercooling of compressed air—to remove moisture by condensing it out in a properly drained cooler—to reduce the volume of the air so as to decrease the pressure drop in an extensive transmission piping system. In most industrial plants neither of these is necessary, and the aftercooler is simply a power waster.

In an existing plant the power saving is the only consideration, but if new compressors are needed, the use of a lower pressure will cheapen and lighten both the compressor and its drive.

Figure it out! Try it! Report your experience!

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for October will be announced this month.

A Little Investment Returns Big Dividends

When a plant owner is asked to appropriate several thousand dollars for improvements to power equipment, he naturally wants to know in what length of time the proposed plan will return his money and if his investment is as well protected as if the money were kept in the bank. I was chief operating engineer in one plant where the owners had the reputation of refusing to lay out money on the power plant, and several chief engineers had given up the job in disgust when refused permission to make changes that were badly needed. I was advised when taking the job that the owners often had the engineer on the carpet about his high coal bills, but would listen to no plans for improving the performance of the boiler plant.

The boiler equipment was composed of two 78-in. and one 72-in. return-tubular boilers, and all were operated at maximum capacity on a 24-hour load. The pressure carried was 120 lb. The steam flow was 22,500 lb. per hour and was used by two simple 4-valve condensing engines carrying a combined load of 1,140 hp., which was beyond their rated capacity.

A few days after I took the job the owner came into the boiler room with a slip of paper in his hand and asked me what I thought of the figures it contained. It proved to be a statement by the former chief to the effect that the 72-in. boiler needed retubing and a tentative estimate of $1,200 to $1,500 for material and labor. I knew that this boiler was in bad condition from a quick examination made the previous Sunday, and stated that it could not run much longer without extensive repairs. I promised to give him an idea of what I considered the best policy on the following day, and devoted the rest of the day and a good part of the night to the problem.

A glance at the inspection certificates revealed the fact that the two 78-in. boilers were allowed a pressure of 155 lb. per sq.in., while the maximum to be carried on the 72-in. boiler was 125 lb. As the cutoff was about one-third stroke with the engines carrying full load, I estimated a saving of from 11 to 13 per cent in steam consumption if we could raise the initial pressure to 155 lb. and secure the benefit of an earlier cutoff and greater expansion. Taking the lower figure, the reduction in steam flow figured 2,475 lb. per hour. This meant carrying the entire load on the two larger boilers; as they would have to generate about 20,000 lb. of steam per hour, the case called for further consideration.

Had the boilers been stoker fired with forced draft, no trouble would have been experienced. With clean fires these boilers could generate the required amount of steam with hand firing as our draft conditions were favorable, but the loss of capacity when cleaning fires was the greatest obstacle. If the owners could be persuaded to buy hand stokers for the boilers, the problem would be solved, since greater capacity would be possible. I estimated that this equipment would cost around $750 per boiler and resolved to make a strenuous effort to secure the consent of the owners to my plans.

When I went to the office the following day with a complete outline of the idea on paper, I was told as soon as I entered that under no circumstances would they spend any money repairing the old boiler and that we would have to operate the plant as it was.

"I did not come in here to ask you to spend any money on that project," I explained; "instead I am submitting a plan for saving you $800 a month on operating expenses."

He was interested at once, but he stated emphatically that my plan must stand the most rigid scrutiny before spending the first dollar.

"We cannot afford to experiment with risky ideas, and our money must show as quick a turnover as if it was invested in any other part of this business," he stated. "Just how do you expect to make such a saving?"

"Our load," I replied, "at present is 22,500 lb. of steam per hour, which calls for 2,700 lb. of coal per hour with an evaporation of 8.33 lb. The increased pressure will reduce this load by 11 per cent, making a net saving of at least 10 per cent, or 270 lb. of coal per hour. Hand stokers will save you 8 per cent of your coal bill, bringing the total saving up to 464 lb. per hour. Now," I continued, "you run 600 hours a month here, which shows the monthly coal saving to be 139 tons. At $6 a ton you are saving $834 each month and in exactly seven weeks and three days your money is returned."

"This equipment pays for itself inside of two months, is that the idea?" he asked.

"Exactly, and from then on the saving of $834 a month, minus an overhead charge of about $20 a month, is all velvet."

The order for this equipment was placed without delay, and after installation the weekly coal record told us that the estimated saving was actually exceeded. At the end of the first month of operation under the changed conditions I was called to the office and the

owner expressed his pleasure at the showing made by the power plant.

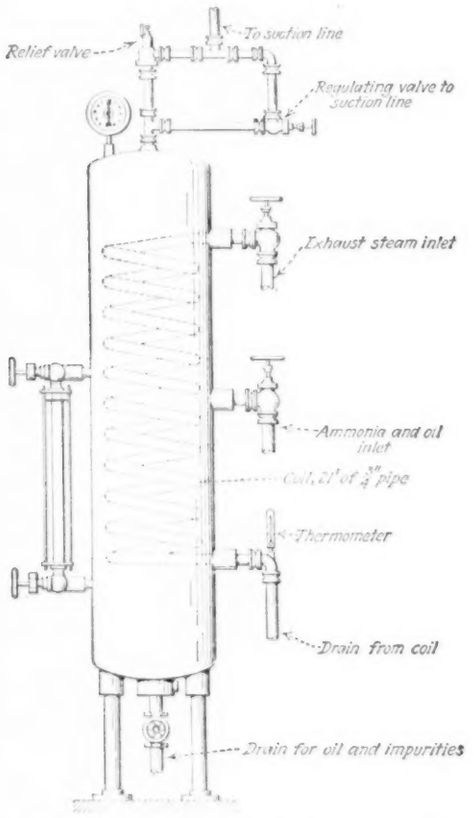
"Is there a chance for further improvement in the boiler room? If so tell us what it is and we will make any reasonable outlay."

I stated that $500 should be spent for boiler instruments and promised an increase in boiler efficiency to repay their cost, pointing out that an increase of only 2 per cent in the boiler efficiency would produce a reduction of nearly $1,000 annually. Within two weeks after the instruments were mounted in the boiler room, the improved operation fully justified their cost, and the owner promised an adjustment of salaries upward for the men responsible for the reduction in fuel costs.

Chicopee, Mass. J. A. MADSEN.

Saving Through Use of Ammonia Regenerator

I was having considerable trouble with oil in the refrigerating system. In fact, things had reached such a state that something had to be done, so I decided to put in a regenerator. By running lines to it from



Regenerator installed to clean ammonia

different parts of the system, I planned to work on one part of the system without interfering with another.

In this particular plant all exhaust, fuel-oil and boiler-feed lines are run through concrete trenches and trenches covered with steel floor plates. I planned to put the lines to the regenerator in the same trenches in order to get a gravity head for the oil from the different parts of the system. From experience I have found this method more reliable than depending on gas pressure to move the oil.

Of course this can be eliminated by close regulation of the regenerator inlet valve, but then there is the choking proposition to contend with.

Other engineers volunteered advice, most of it being to the effect that the investment was not justified. One listed regenerators as non-essentials and dangerous, always blowing up, troublesome from start to finish; another could see no advantage in having a gage glass, as the frost line would be sufficient; a third thought it wrong to use an exhaust-steam coil, while another thought it wrong to run lines through a trench where the temperature was around 145 deg. F., but the job went on.

The installation proved satisfactory, and with the gage glass properly located, I can carry about three gallons of oil, which just about covers two lower turns of the spiral heating coil. There is no guesswork attached to it. Where ammonia is admitted, it partly mixes with the oil and the boiling action takes place gradually, causing no confusion and there is no frost. Lack of frost means lack of rust and corrosion on the shell and there is no drip to the floor. The drain from the steam coil is open and allowed to drip. With proper regulation of steam inlet, vapor is noticeable at the drip, so there need be no fear of freezing the coil.

By running the lines through the hot trenches the heat has a tendency to evaporate or gasify a considerable portion of the pure ammonia, which returns to the system, leaving less work for the regenerator to do.

During operation I have taken samples from time to time, the first showing as high as 12 per cent of water. This has gradually decreased until after six weeks I find only a trace of water. During the six weeks of operation 45 gal. of oil and water have been taken out with no loss of ammonia. After filtering, etc., I have 32 gal. of surplus oil that shows a flash point of 303 deg. F. and a freezing point of —1 deg. F.

It is now possible to slow down the machine 10 r.p.m., cut one hour off the running time and carry brine temperature three degrees lower than before.

San Francisco, Calif. J. R. STAPLETON.

Improvised Oil Cooler for Small Steam Turbine

Most steam turbines are equipped with oil-circulation systems that include an adequate cooling system. Some time ago I was confronted with a 2,000-kw. turbine that was giving a lot of trouble due to the oil sludging. The machine had water-jacketed bearings, but no other method of cooling the oil. This proved inadequate for the purpose, and the consequence was that the bearing-oil temperature ranged from 160 to 180 deg. F. This was unsafe and costly as well, as the oil sludged with great rapidity and a single charge lasted but a month to six weeks.

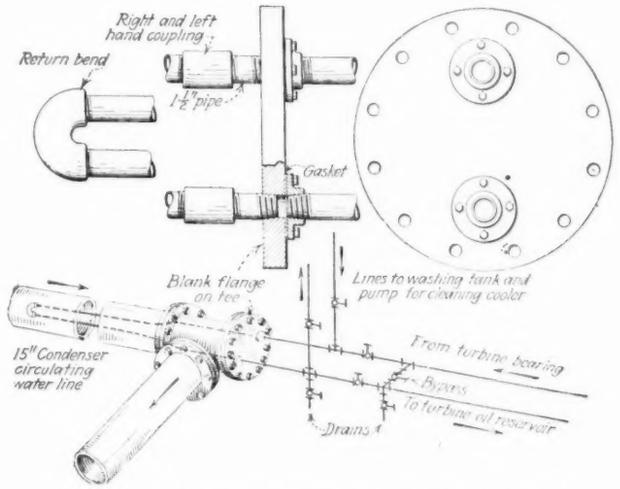
To overcome this we rigged up the simple cooler shown in the sketch and connected it into the oil-circulation system so that all the oil would pass through it.

This cooler is made of standard pipe fittings, consequently the expense involved is not great. As will be seen from the illustration, it consists of a long U of pipe placed inside the condenser-circulating water intake pipe coming from the river. It is easily removable for cleaning.

If it is found that the temperature of the oil going

to the bearings falls below 115 deg. F., making it too viscous and hard to filter, the bypass valve between the oil lines running to the cooler is opened to permit only part of the oil to go through the cooler. By regulating this valve, the temperature may be kept at the most favorable point.

If desired, two outlets may be installed as shown, one leading from a washing tank and pump to the inlet side of the cooler, and the other returning from the



Details and arrangement of turbine oil cooler

outlet side of the cooler to the washing tank. When the turbine oil circulating system is drained, this washing tank is used to pump washing solution through the cooler to remove any sludge that clings to the inside of the pipe. A good cleaning solution is readily made by adding 3 oz. of commercial tri-sodium phosphate and 3 oz. of commercial soda ash to each gallon of hot water used. To this may be added 1 oz. of soap powder if the sludge deposits are hard to remove. This solution should be kept hot with steam while pumping through the cooler. It must be thoroughly washed out of the pipes with plenty of hot water before returning the cooler to use. This arrangement will obviate the necessity of taking the cooling coil out of the circulating pipe for cleaning.

G. H. CORNELL.

Jackson Heights, N. Y.

Checking Steam-Trap Leakage

Among the various losses incurred in the generation, transmission and use of steam, there is one item often overlooked which may well deserve a brief study, and this is steam-trap leakage and efficient disposal of condensate.

Most all steam and condensation traps on the market today are efficient and free from leakage when first installed and for some time thereafter; but like all mechanical apparatus, they require more or less frequent inspection. It is a well-established theory in power-plant practice that to install a machine or mechanical apparatus with a view of making it easy for inspection and maintenance is the best form of insurance for sustained efficiency and long life. This same principle should be carried out where practicable in the installation of steam traps.

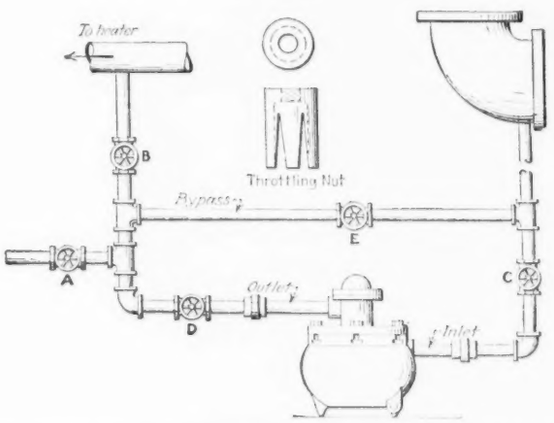
The method of connecting a trap shown in the illustration makes it readily accessible for a leakage test or removal for repairs. This arrangement allows the operator to make a quick leakage test by first opening valve *A* and closing valve *B*, watching the trap discharge condensate and the closing characteristics. If, upon finding a condition of leakage, the operator desires to remedy the loss, he closes valve *C*, releases the pressure in the trap by opening the air vent or other suitable valves, then closes valve *D* and cracks open the bypass valve *E*. This valve should have a throttling nut on its disk as shown in the detail, to prevent wiredrawing its seat.

LOSS OF STEAM THROUGH CIRCULAR ORIFICE FROM 159 LB. ABS. TO ATMOSPHERIC PRESSURE BASED ON NAPIERS FORMULA

Dia. Inch	Dia. and Area of Circular Orifice Area Sq. In.	Weight of Steam Discharged per Hr., Lb.	Weight of Steam Discharged per Week, Lb.	Cost of Steam Leakage per Week Based on Cost of $0.25 per 1,000 Lb
1/64	0.000192	1.47	247	0.06
1/32	0.000767	5.89	989	0.24
3/64	0.001726	13.23	2,217	0.55
1/16	0.003068	23.72	3,981	0.99
5/64	0.004794	36.72	6,165	1.54
3/32	0.006903	52.78	8,870	2.22
7/64	0.009396	71.91	12,079	3.02
1/8	0.01227	94.09	15,808	3.95
9/64	0.01553	118.57	19,824	4.95
5/32	0.01917	146.11	24,528	6.12
11/64	0.02320	177.48	29,736	7.43
3/16	0.02761	211.14	35,448	8.85
13/64	0.03240	247.86	41,664	10.40
7/32	0.03758	286.87	48,216	12.05
15/64	0.04314	328.95	55,272	13.82
1/4	0.04909	374.85	63,000	15.75

The trap may now be taken out of the line by uncoupling the inlet and outlet unions, and the defective parts replaced or repaired as the case may be.

The bypass arrangement and test connections shown in the illustration are by no means new. Many power plants are standardized on this system, but there are also many plants that have no means or schedules for testing or inspecting traps and to these in particular the accompanying table will be interesting. The losses



Trap connection arranged to permit a quick leakage test

given in the table are based on Napiers' approximate formula $W = \frac{PA}{70}$, where W = flow in pounds per second, P = absolute pressure and A = area of orifice in square inches.

The piping to and from a steam trap should be well insulated and the condensate from traps should be piped to a common header going to a feed-water heater or water-storage tank to be used as boiler-feed makeup. In some plants the condensate is discharged directly into the boiler by means of a receiver trap placed over the boiler. The heat recovery in either way is efficient.

Jersey City, N. J. E. A. BAERER.

Comments from Readers

Using the Operating Force on Maintenance Work

An editorial in the Sept. 19 issue of *Power* suggests an idea that can be applied in many power plants and with considerable benefit to the operating crews. The working of men in four shifts, three operating shifts and one shift on maintenance, would be welcomed by the operators and would be a distinct advantage to them. It would afford an opportunity for experience on maintenance which possibly could not be secured in any other way, as in plants of 1,000 kw. and more operating on a 24-hour schedule, an operator is rated more by his ability to keep equipment running than by his mechanical ability.

If he is to step up into a higher position, he must be careful of supervising all repairs, and if he lacks this valuable training he is likely to fail when promoted to a chief's job. Many an operator never does anything but operate and would make a poor showing if he tackled the job of engineer-in-charge and had to oversee all repair to equipment, and even all pipefitting and electrical work throughout the factory. By working these men on maintenance work they would acquire valuable experience and would develop into engineers of considerable executive ability, and in case of a position higher up being open, it could be filled by a man already in the organization instead of the management being forced to look outside for a man with all-around experience.

The crew would be in better physical condition, due to the fact that they work more day shifts and come on the night shifts less often. There is only one day operating shift, and the amount of time spent on day work would be doubled by the adoption of this idea. Undoubtedly, the plant would be kept in better shape under this system. A fireman assigned to several day's duty cleaning the tubes of water-tube boilers will no doubt do a more thorough job, since he has to keep up steam when returning to his operating duties and has more interest in this work than a repair man.

I do not agree with the opinion expressed that operating labor is cheaper than maintenance mechanics. In this section the average hourly wage of operating engineers is above that of machinists, pipefitters, millwrights and electricians in industrial plants, and firemen's wages are nearly on a par with mechanics' wages. The adoption of the plan would call for the substitution of licensed engineers in place of ordinary mechanics or the plan of using apprentices under a definite system of training. It certainly breaks up the monotony of operating on night shifts and forces a man to associate more with other workers in the plant and possibly will develop a co-operative spirit, which is often lacking where a man is alone on night duty constantly.

It will broaden a man's viewpoint and will keep him from being discouraged, as so many men over forty often remark that there is no chance for advancement in engineering. There is far greater chance for advancement for an engineer if he can take charge of all maintenance work in a plant instead of being only a good operator.

A. F. SHEEHAN.

Brightwood, Mass.

Combustion of Pulverized Coal with Different Degrees of Fineness

Referring to Mr. Brinckerhoff's comment in the Sept. 29 issue on "Combustion of Pulverized Coal with Different Degrees of Fineness," there are a few points that I would like to mention in connection with this discussion.

Tests of large installations where pulverized coal is used as fuel, have not shown any apparent difference in efficiency with coal of 200-mesh fineness and that of somewhat coarser pulverization, for the reason probably that the method of burning that was employed was such as did not take full advantage of the qualities posessed by the finer fuel. Theoretically, the finer powder can be more intimately mixed with the combustion air, will burn with greater rapidity when ignited, and consequently will liberate a greater amount of heat per unit of time for the same amount of fuel. Methods of burning fuel are of value as they excel in this latter respect, granting of course that combustion is complete.

At present in the larger installations there seems to be no advantage to be gained from the finer pulverization, but the gain is more marked in the smaller plant, especially where there are high ratings. In the smaller combustion space there is not sufficient time for the coarser particles to be consumed before entering the tubes, especially when the quantity of fuel is increased to meet an increased demand on the boiler.

By smaller combustion space I do not mean less furnace volume per square foot of heating surface, but rather the linear dimensions of the combustion chamber which must necessarily be smaller and therefore afford less space for the travel of the ignited particles of fuel before they reach the boiler tubes.

One of the chief objections to extremely fine powder from the point of view of economy is the cost of producing it. Power consumption and wear and tear on the pulverizer increase rapidly with increasing fineness of the product, and a point is soon reached where any increased gain from combustion efficiency due to the finer pulverization is offset by the increased cost of producing the finer powder.

It must be conceded, however, that from a combustion point of view there is advantage in finer pulverization, but the problem is to produce the fine powder economically and to devise a method of burning that will enable the advantages possessed by the finer particles to be utilized to the fullest extent.

Schenectady, N. Y. S. C. MARTIN.

Surface-Condenser Operation

In the Oct. 6 issue, Paul H. Jeynes describes in an interesting and instructive way surface-condenser operation. The location of a thermometer for reading the temperature of the exhaust steam, as shown in Fig. 4 of the article, has been subject to criticism many times. If a thermometer were placed in the exhaust-steam nozzle of the condenser, as indicated by Mr. Jeynes, it would be subject to the impingement of high-velocity steam.

The particles of steam striking the thermometer bulb have their kinetic energy changed into heat energy, and as a result the thermometer will show a temperature slightly higher than that corresponding to the absolute steam pressure in the condenser.

It has been my experience that more reliable temperature readings are obtained if the thermometer is placed at a point in the condenser nozzle where the steam is more or less quiescent; for instance, in the atmospheric relief-valve connection. F. W. RABE.

New Haven, Conn.

Phasing Out Alternating-Current Generators

In the Oct. 20 issue Edward Swan writes an interesting article on phasing out alternating-current generators. I believe, however, that the method of using a three-phase motor for this purpose is open to criticism in some cases. A few years ago it was desired to operate an electrically driven pumping station by means of two banks of transformers, either singly or in parallel.

One bank consisted of three 200-kva. transformers for stepping down from 25,000 to 2,300 volts. The other bank was the same, except the transformers were of 75-kva. capacity. Each bank was connected closed delta on both primary and secondary. The erecting engineer carefully traced the primary and secondary wiring so as to avoid the necessary "phasing out" if possible.

The primary switches were closed and the current brought to the switchboard. The voltage was the same

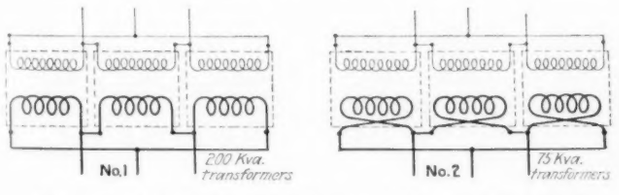


Fig. 1—Original connections of the two banks of transformers

in each phase of each bank. The engineer next started a 200-hp. three-phase motor for checking the direction of rotation. This was apparently correct for both banks. He then attempted to parallel the two banks, but disaster immediately followed.

When the smoke cleared away, it was found that the six primary 25,000-volt fuses were destroyed and the smaller transformer bank damaged so that extensive shop repairs were necessary.

It was known that the transformers were of different makes, and it was assumed that they were of the same polarity. This, however, proved not to be the case as it was found upon consulting the records that the No. 1 bank was connected for negative or subtractive polarity while the No. 2 bank was the opposite. Thus, in this particular case the motor test on which the engineer based his conclusion, failed to give the correct indication.

Figs. 1 and 2 show the general scheme of transformer connections used. Fig. 1 shows the connections of the two banks as they were first grouped, and Fig. 2 shows how they were finally connected when put into successful operation. Summing up, I believe that Mr. Swan's plan of using three transformers and lights is the surest and safest for all-around phasing-out alternating-current equipment. M. A. ANDERSON.

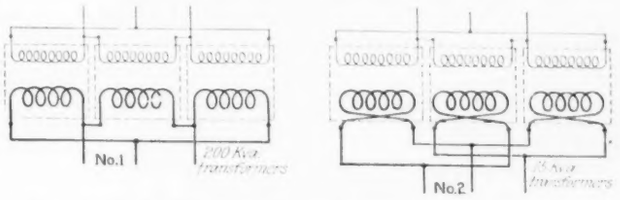


Fig. 2—Connections of transformers as they were finally made

Pittsburgh, Pa.

Brine Tanks

In the Oct. 6 issue of *Power*, under "Practical Ideas," there was a suggestion submitted by R. L. Tullis.

Refrigerating coils submerged in brine and the brine tank insulated, would not refrigerate a room, any more than the coils themselves if insulated to prevent the transmission of heat from the air in the room to the pipe, would do so.

If Mr. Tullis will stop to consider the subject of heat transmission, he will recognize the fact that in heat exchange the heat travels in one direction only; that is, from the warmer body or substance to the colder body or substance. Heat can be exchanged in only three ways: By radiation, as heat from the sun; by conduction, as from the fire side of a boiler wall, through the iron, to the water side of the wall; and by convection, wherein a body is heated, then moved to another location, carrying the heat with it.

In refrigerating a room, the process of cooling is done almost entirely by *convection*, and in this application air is the body that picks up the heat and conveys it to another location. For example, when warm goods are put into a room to be cooled, as the air in the room is colder than the goods, the heat in the goods flows into the air, causing it to become warmer. The air expands, rises, and comes into contact with a pipe that is colder than the air; the heat then flows into the cold pipe, this causes the air to become colder, to shrink and flow downward, where it again picks up heat as before.

It will be seen that any device or material that prevents the air from coming into contact with the colder pipe, will stop the exchange of heat.

There are, of course, other conditions that affect the flow of air, such as moisture content, but these either hasten or retard the velocity of the air flow and do not alter the natural law as stated. M. R. CARPENTER.

Chicago, Ill.

Psychological Tests for Engineers

The editorial on page 371, of *Power*, Sept. 8, introduces a subject that, I am sure, is of more than ordinary interest to all engaged in the profession. It deals with the one phase in the makeup of an engineer that cannot be obtained from any college in the world or by a lifetime of practical experience. "To act correctly when an emergency arises," as your editorial puts it, is something that cannot be acquired, and the man without it is always to be pitied in all walks of life, but particularly in the power field, where the lives of many may be lost by his failure.

In all sections of the engineering field the psychological side plays an important part, and while the suggested tests might in some cases entail hardship, this would be more than balanced by the certainty that our engineers could be relied upon to come up to the standard of "that engineer who saw his duty a dead sure thing and went to it there and then."

Belfast, Ireland. F. P. TERRY.

High Pressure for Industrial Plants

The description of the 1,200-lb. plant at Weymouth in the Sept. 15 issue of *Power* and the editorial on the subject of the application of 1,200 lb. pressure to industrial plants point the way to remarkable economies in power generation in industries requiring process steam at high back pressure.

It may interest some of the readers of *Power* to analyze the power problem of some particular plant and see just what the saving in dollars and cents will be, by increasing the power output of back-pressure engines with high-pressure steam. In this state there is a pulp and paper mill operating a 500-kw. non-condensing turbine at 200 lb. absolute initial pressure and exhausting at 110 lb. back pressure into digesters. Obviously, the steam rate of the turbine is high under these conditions, and with a load of 500 kw. steam flow through the turbine is 55,000 lb. per hour, showing the steam rate to be 110 lb. per kw.-hr. Since the power requirements of the mill exceed 500 kw., the remainder of the power is either purchased or generated by condensing units.

If the initial pressure was 1,200 lb., the output of the non-condensing unit could be quadrupled as will be shown. The article gave the steam rate of the 1,200-lb. turbine at 350-lb. back pressure at 42.22 lb. per kw.-hr., and if the back pressure was reduced to 200 lb. absolute the water rate would be reduced to 29.6 lb. assuming a Rankine efficiency of 70 per cent for the stages expanding steam between 350 and 200 lb. pressure. Therefore the output of a turbine expanding steam from 1,200 lb. and 700 deg. F. will be 1,858 kw. with a steam flow of 55,000 lb. per hour and added to the output of the unit already installed in this plant, brings the power output from 500 kw. up to 2,358 kw. with the same steam flow. This is equivalent to a reduction in pounds of steam per kilowatt-hour of 78 per cent, since the final steam rate is brought down to 23.32 lb.

Assuming that current can be purchased for ¾c. per kilowatt-hour and that 1,800 kw. or over is being purchased, the saving in cost of purchased current is $13.50 for each hour of operation. Industries of this type have an operating schedule of 24 hours a day and 300 days a year, so the possible saving runs as high as $97,200 per year. This amount would pay 37 per cent on an investment of $261,000 for a 1,800-kw. plant, it being assumed that the cost of a high-pressure turbine of 1,800 kw. capacity and a boiler to generate 55,000 lb. of steam per hour is in the vicinity of $145 per kilowatt and that the plant contains the required space for additional units. If 1,800 kw. is being generated with a condensing turbine in this plant with a fuel allowance of 1½ lb. per kilowatt-hour, the fuel saving at $6.50 per ton, is $63,180. Of course the heat content in each pound of steam is considerably more, so if air preheaters are used the cost per pound of steam need be no higher at the increased pressure. But the cost must be reduced considerably below $145 per kilowatt or the fixed charges will be nearly two-thirds the fuel saving. At $100 per kilowatt the high-pressure equipment is an excellent investment, a net saving of about $30,000 being possible.

In another plant devoted to tire and rubber manufacture, 80,000 lb. of steam per hour is generated at 150 lb. pressure and used at 100 lb. in process work, no power being generated from the process steam. This plant has a bill for current of about $10,000 monthly and uses 32,000 tons of coal a year. The total cost for fuel and power is around $312,000 annually, and with a 1,200-lb. pressure unit exhausting at 100 lb. back pressure the entire present cost of current could be eliminated without any increase in the fuel consumption. The power now costing $120,000 a year with a rate of 9 mills per kilowatt-hour shows the current consumption to be 13,333,333 per year and operating around 7,000 hours a year, the connected load does not exceed 2,000 kw. This gives a permissible water rate of 40 lb. for a high-pressure unit, which allows a pressure of less than 1,200 lb. to be used here. It is safe to say that the net saving would be $60,000 annually, allowing $60,000 for fixed charges on the equipment. But in cases like this there is probably a long-term contract with the power company which prohibits the adoption of the plan outlined. There is nothing to prevent the power company from contracting to sell steam at 100 lb. pressure to their customer and installing a 1,200-lb. plant on the premises and supplying the required amount of process steam by the turbine exhaust, provided a reduction in steam cost is guaranteed the manufacturer.

The plant in question is not equipped for low-cost steam production, and if the high-pressure boiler plant is properly designed, has the most economical combustion system and air preheaters along with feed heaters extracting steam at least two pressures, steam could be generated at 1,200 lb. at a lower cost per thousand pounds than is now being done. Bleeding steam at 100 lb. and 350 lb. would give a feed temperature of 420 deg. F. and would bring the water rate of the turbine down to the vicinity of 25 lb. per kilowatt, and with a steam flow of 80,000 lb. per hour the unit would generate 3,200 kw. or 1,200 kw. above the user's requirements. This excess current would enter the lines of the power company.

If the power company were generating current in a condensing station at a fuel rate as low as 1.2 lb. per kilowatt-hour, the fuel consumption of this station would be reduced by 3,840 lb. per hour, or 13,440 tons a year. In addition to the fuel saving, there would be an increase in the power company's revenue, as some profit is possible from the sale of steam and transmission losses are greatly reduced. M. BUCKLEY.

Indian Orchard, Mass.

Questions and Answers

Conducted by

Franklin Van Winkle

Required Increase of Stack Capacity

We have installed a boiler having 5,000 sq.ft. of heating surface, connected to the old brick stack, which has a flue 44x44 in., 85 ft. high, and do not obtain sufficient draft for developing the rated capacity of the boiler. Is the old stack large enough for the new boiler, and if not, what should be its height? E. W.

The height required for a stack of given size of flue depends on the kind, quality and quantity of fuel that is to be burned, the length and form of connections between boilers and stack, the location with respect to near hills, etc., and weather conditions. Under ordinary conditions, for burning as much as 0.4 lb. of good coal per square foot of boiler-heating surface per hour, a square brick stack 85 ft. high for 5,000 sq.ft. of heating surface should have a flue not less than 52x52 in. in the smallest part. For a height of only 85 ft. the present 44x44-in. flue is about 760 sq.in. too small, and to furnish sufficient draft, the present size would need to have a height of 180 ft.

The most economical improvement of capacity would be to provide additionally a round stack with flue at least 32 in. in diameter, 85 ft. high.

Pipe Coil for Precooler

It is desired to make a coil for a precooler to reduce the temperature of 50 gal. of water per minute from 80 deg. F., to 60 deg. F. How many lineal feet of 1¼-in. pipe would be necessary to have in coil, using direct expansion suction pressure of 15 gage and head pressure 160 lb. gage? M. G.

The formula to be used in determining the amount of coil surface is,

$$H = KAT$$

where

H = Number of B.t.u. to be removed per hour;
K = Coefficient of heat transmission, which in the case of the cooling-water tank is 10 B.t.u. per hour per deg. F. temperature difference;
T = Temperature difference between the water and ammonia.

The specific heat of water C is unity; that it, 1 lb. of water requires 1 B.t.u. to raise its temperature 1 deg. F. The total heat to be removed is, then,

$$H = CWT$$

where

$C = 1$;
$W = 60 \times 50 \times 8.33 = 24{,}990$ lb. per hour;
$T = 80 - 60 = 20$;
$H = 1 \times 24{,}990 \times 20 = 499{,}800$ B.t.u.

Substituting this value in the first formula, we have,

$$499{,}800 = 10\ AT$$

The pressure of the ammonia in the coils is 15 lb. gage, making its corresponding boiling temperature 0 deg. F. Since the water temperature ranges from 60 to 80, the formula for the mean temperature difference is

$$Tm = \frac{T_1 - T_2}{\log_e \left(\frac{T_1 - T_a}{T_2 - T_a}\right)}$$

where

T_1 = Inlet water temperature = 80 deg. F.;
T_2 = Outlet water temperature = 60 deg. F.;
T_a = Ammonia temperature = 0;
$\log_e$ = Hyperbolic logarithm.

Substituting the proper values,

$$T_m = \frac{80 - 60}{\log_e \left(\frac{80\text{-}0}{60\text{-}0}\right)} = \frac{20}{\log_e 1.33} = \frac{20}{0.285} = \mathbf{70\ deg.\ F.}$$

We can then write,

$$499{,}800 = 10 \times A \times 70$$

$A = 714$ sq.ft.

As 2.3 lin. ft. of 1¼-in. pipe is required for 1 sq.ft. of area, the linear feet required is $714 \times 2.3 = 1{,}642$.

Oil for Air Compressor

Can you inform me where reliable information can be obtained on the use of oils in air compressor cylinders? I am expecting to use compressed air at extremely high temperatures as well as high pressure and am informed that the limiting factor in such a problem is the difficulty in obtaining a lubricating oil that will not explode in a compressor at the high temperatures. S. C. R.

Complete data in regard to the particular kind of lubricating oil required with high temperature air can be obtained of any reputable oil company. However, the cheapest and safest way to obtain extremely high temperatures with high-pressure air is not to compress the air in a multi-stage compressor without inter coolers, or in a single-stage compressor, by which methods the air would contain all the heat added to it by compression and would, consequently, show a very high temperature. It is more economical to compress the air in a multi-stage compressor with intercoolers between the several stages, so that the air temperature, after compressing in the low-pressure cylinder, is brought back as close as possible to atmospheric temperature and this process continued after each stage. The discharge temperature then may be in the neighborhood of 100 deg. F., and any desired temperature can afterward be obtained by passing the discharge air through an afterheater, which may be in the form of a small vertical boiler. The work required by compression by this practically isothermal method is so much less than that required by a compressor which has no intercooler that the method of adding heat in an afterheater is not only feasible, but advisable. Following this method any good compressor oil would be suitable because your temperature would never rise to any dangerous amount.

Putting Air in Pressure Tanks on Hydraulic Elevators

On hydraulic elevators how is the air supply maintained in the pressure tank and what is its purpose? *B. W.*

Air is introduced into the pressure tank either by an independent air compressor or by throttling down the suction valve on the water pump and opening an air-intake valve. Where there are centrifugal pumps with considerable slippage due to wear, and where there is violent agitation of the water in the surge tank, sufficient air may enter the suction to keep the system supplied. In fact, such a system sometimes has to be relieved of air. The function of the air is by its expansive force to cause water to flow from the tank to the cylinder when the controlling valve is open. Water alone will not do this satisfactorily because it is practically incompressible. A combination of the two is necessary and is ideal for performing this function. To pump directly into the elevator cylinder would require the use of equipment much larger than is otherwise necessary. Moreover, even if the pump were of the centrifugal type or had a great many cylinders, the car would not ascend with a smooth motion.

Gaging Rate of Steam-Flow by Substitution

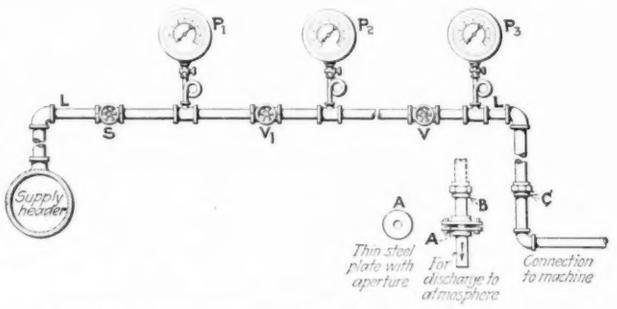
How can we make a test of the quantity of dry saturated steam furnished per hour to a finishing machine from which much of the steam is discharged without becoming condensed, which precludes reliance on the weight of condensate discharged? *C. R. H.*

The rate of flow can be measured by a steam-flow meter placed in the supply line to the finishing machine; or the quantity of steam in question may be determined by establishing conditions to obtain and calibrate the same rate of flow in the supply line with the discharge taking place into a condenser from which the weight of steam flowing in a given time can be known from the weight of condensate obtained; or the rate of flow can be determined by the rate of discharge through an aperture under identical pressure conditions.

For measuring a substitute flow through an aperture with control of the conditions, it would be well to have three stop valves S, V_1 and V, and three pressure gages P_1, P_2 and P_3, in the supply line to the finishing machine, with a lip union connection to the machine as shown in the figure; and also prepare a thin steel disk A with an aperture estimated to be no larger than necessary for passing enough steam from the regular supply of the finishing machine. Have the diameters of the disk no larger than necessary for it to be held between the flanges inside of the bolts of a flange union connected to a nipple and half lip union B for connection in place of connection C.

When the finishing machine is supplied from the steam header through the stop valve S and supply line LL, and the regular stop valve V, the full header pressure is not realized on account of the throttling action of the supply pipe and fittings. Insertion of a valve V_1 causes further reduction of the pressure, the amount depending on the adjustment of this valve.

The difference of the readings of pressure gages P_1 and P_2 will show the drop of pressure between their points of connection with the supply line, and a pressure gage P_3 placed beyond the valve V will indicate the pressure of steam supplied to the finishing machine. Make a setting of valve V suitable for supplying the finishing machine in regular operation and note the pressure indicated by gage P_3. Now regulate the amount of opening of valves S, V_1 and V so the desired discharge pressure will be shown by gage P_3 with P_1 indicating a pressure that can be maintained between valves S and V and so there will be a decided drop between P_1 and P_2 from adjustment of valve V_1. Then without disturbing the adjustment of V_1, replace the discharge to the finishing machine by connecting the flange union for discharge through the aperture to the atmosphere when there is the same pressure as before on each side of valve V_1. This can be obtained by



Gaging steam consumption by establishing and measuring the same rate of flow

regulation of the main stop valve S for changes of header pressure and by adjustment of valve V.

The discharge through the same valve aperture V_1 with the same difference of pressure shown between P_1 and P_2 then will be at the same rate as when the furnishing machine was supplied, and the rate of discharge can be computed with great enough accuracy for most practical purposes, by Napier's approximate rule:

Pounds of steam flowing per second = absolute pressure $P_3 \times$ area of aperture A in sq.in. $\div$ 70.

The pressure shown by gage P_3 when steam was delivered to the machine may be lower when discharging through the measuring aperture to the atmosphere, because the aperture may chance to be larger than necessary. This, however, is immaterial, provided the pressure indicated by gage P_3 is high enough to be observed with accuracy and the same pressures are obtained on gages P_1 and P_2, and there is the same setting of valve V_1 as when the machine was supplied.

If when discharging through the aperture the pressure shown on gage P_3 is higher than in regular operation of the finishing machine, the aperture in the disk should be enlarged or a disk with larger aperture should be employed.

In place of computing the flow through an aperture based on its size and the pressure obtained on gage P_3, the flow may be discharged to a tank or barrel partly filled with water, and the increase of weight in a given time, due to the addition of condensate, would be the weight of steam used by the finishing machine in the same time, provided there is the same pressure shown by gages P_1 and P_2 and the same setting of valve V_1.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication, and for the inquiries to receive attention.—Editor.]

Engineers Discuss Refrigerating Economies

THE New York Chapter of the National Association of Practical Refrigerating Engineers devoted its Nov. 12 meeting to a round-table discussion of plant economies.

Among other operating procedures covered was that of defrosting of expansion coils in cold-storage rooms. J. Bernd described a simple system used in his plant, where there are four sections of expansion pipes. It used to cost $62 in labor to knock the ice off these coils. To save this expense, he made a 1-in. hot gas connection from the compressor discharge line to the outlet of each of the sections, closed the expansion valve and the return valve of the section to be defrosted, and introduced hot gas into the outlet end of this section, the coil acting as an ammonia condenser. After the section had filled with warm liquid and the ice had become loose, the expansion valve was opened and the liquid slowly fed all day into the other coils, instead of drawing fresh liquid from the receiver. Thus there was no loss in heat, and the ice storage room temperature remained unchanged. Defrosted cold coils refrigerate much more effectively than do coils heavily coated with ice of room temperature.

Advantages of Compound Compressors

H. P. Hill gave an elementary description of two-stage ammonia compression, contrasting it with single-stage compression. He pointed out that in a simple compressor where the ratio of absolute pressures is 200 to 30, or 6⅔ to 1, the losses are such as to make the true volumetric efficiency not better than 75 or 80 per cent, and the mechanical efficiency about 85 per cent.

When the work of compression is distributed over two cylinders, the low-pressure cylinder discharging with 75 lb. absolute and the high-pressure discharging with 200 lb., the ratio in each cylinder is less than 3 to 1. This keeps down the losses from re-expansion and cylinder heating, and allows of cooling the intermediate-pressure gas with water. The lower discharge temperature permits higher rotative speed, which leads to smaller cylinder sizes, cheaper motors, and brings the mechanical efficiency up to at least 90 per cent, while the over-all saving over simple compression increases as the ratio of compression is increased. He stated that in any case it was essential to have ample valve area.

Some early two-stage machines suffered from insufficient number of valves, necessitating frequent renewals. After the compressor heads had been changed and the total valve area materially increased, the gas velocity diminished from 18,000 to 6,000 ft. per min. In economical ice plants the subcooling of liquid and the forecooling of can water should be done at about 40 lb. gage pressure.

The speaker went on to explain the advantage of an ammonia liquid pump as employed at the 1,000-ton ice plant of the Arctic Hygeia Ice Co., New York. During winter none of the machines supplied was small enough for the demand. As it would not do to return unevaporated liquid to the compressor, a special liquid pump with a solid steel cylinder was built to force the liquid accumulating in a large tank in the ice-storage room back into the high-pressure liquid line. This allowed of flooding the ice-tank coils liberally with liquid, which in turn increased their heat-absorbing capacity and permitted carrying a suction pressure of about 30 lb. gage, resulting in economical refrigeration. The warm liquid was subcooled by passing through coils surrounded by suction gas or cold liquid in the large accumulator tank in the ice storage.

Using Thermometers

J. Bernd also emphasized the importance of balancing the output of machine and freezing tanks, which can be done by observing the suction-gas thermometer, but is more readily accomplished where the compressor is equipped with clearance pockets, and where a venturi ammonia meter is provided.

In answer to an inquiry as to the best way for removing oil from ice-tank coils, J. Bernd stated that the generally advocated plan of blowing out coils with steam and compressed air was obsolete, unwise and unnecessary. He had done it that way once only. He now fills all cans with about 60-deg. water, to let the brine rise above 32 deg., then opens the expansion valve wide for 20 minutes. This will dislodge the warm oil, so it will be carried forward through the suction scale trap and the compressor into the hot-gas oil separator, from which it can be drawn off. To cause highly heated oil vapor to condense, he water-cools the oil separator.

Heat Exchanger

H. Herter explained that with the flooded system and with a high evaporator pressure the movement in the coils was necessarily slow. The oil, being cold and heavier than ammonia liquid, settled on the bottom of the lowest pipes. To churn up the entire contents, it was necessary to bypass the accumulator and to feed the high-pressure liquid direct into the freezing coils for half a day, say once a month, so as to transfer the oil back to the compressor. If a water-cooled heat exchanger was inserted into the discharge line of the compressor, it would catch most of the oil. An oil separator located at the entry to the condenser header will trap more oil than the separator at the machine. If one was desirous of knowing the amount of oil in the system, records could be kept and the weight of oil reclaimed from drains compared with the weight of oil fed to the compressor. Unless the system is cleaned occasionally a large amount of oil will accumulate and decrease the efficiency.

The Theory of Steam Traps

In *The Sibley Journal of Engineering* for October, 1925, page 382, L. C. Price discusses the theory of the design and testing of steam traps. The discussion is confined to bucket and bowl traps, which dump when the bucket or bowl is filled with sufficient water to overbalance the counterweight.

The maximum or ultimate capacity of such a trap is determined by the size of the valve, as the maximum rate of discharge occurs when water flows into the trap so fast that the container remains in its lower position, holding the valve continuously open. When no water is flowing into the trap, the container stays in the upper position, holding the valve to its seat. With either of these conditions the trap does not dump at all, that is, the dumping frequency is zero. Between these two extremes the trap will dump periodically at a frequency depending on the rate of water flow.

Mr. Price shows that the maximum dumping frequency occurs when the trap is discharging water at a rate equal to one-half of its ultimate capacity. Furthermore, this maximum frequency of dumping is equal to the ultimate capacity of the trap, divided by four times the weight of water the trap itself will hold. The importance of this follows from the fact that the life of the wearing parts of a steam trap is inversely proportional to the dumping frequency. It is therefore desirable to select a trap such that the dumping frequency will be low under operating conditions.

How To Test a Steam Trap

Mr. Price remarks that a steam trap may be tested by connecting the inlet of the trap with both the bottom and the top of a steam boiler, so that both steam and water may be supplied to the trap, the flow of water to be varied by adjusting a valve in the water line. During the filling period, water flows into the trap due to the head existing between the trap and the water level in the boiler. When the trap dumps, however, steam must flow into the trap to replace the water discharged, and it is probable that water clinging to the surface of the pipes is brought down with the steam and in addition the flow through the water connection may be increased owing to the slight drop in pressure that must occur. The results are that the dumping period is prolonged, the quantity of water discharged is greater than if the steady flow were maintained, and the frequency for a given capacity is decreased. It follows that the most accurate data can be secured when the trap is operating at a low capacity, that is, when the time of dump is relatively short as compared with the time of fill.

To summarize, it is evident from the relations developed that the dumping frequency of any steam trap of the type discussed is inversely proportional to the weight of water that the trap can collect before dumping, and that the maximum dumping frequency is directly proportional to the trap's ultimate capacity. If, therefore, a trap of low dumping frequency is desired, the size of the trap should be large for a given

ultimate capacity. Since the ultimate capacity is likely to be the first thing decided upon, the water capacity of the trap must be made as large as is consistent with compactness and low first cost, if it is desired to keep the dumping frequency low.

In selecting a steam trap for a given job, the size to be selected is one having a fairly large holding capacity, and an ultimate capacity either considerably more or considerably less than twice the rate at which water is to be handled. An ultimate capacity equal to twice the water-flow rate is to be avoided, as under this condition the dumping frequency of the trap will be greatest.

Trends in Boiler Development

Basic ideas in boiler design have not changed in recent years, and at the present time there is little tendency toward new departures in boiler development, declared P. C. Idell, of the Babcock & Wilcox Co. (Boston), at a meeting of the New England Plant Engineers' Club, Boston, Oct. 14. When boiler practice and development are viewed over a period of twenty years, however, great changes are apparent, as indicated by the following table:

	Twenty Years Ago	Today
Heating surface, average sq.ft.	2,500	12,000
largest, sq.ft.	6,040	40,000
Working pressure, average, lb. per sq.in.	225	350-650
Working pressure, highest, lb. per sq.in.	.....	1,200
Temperature, deg. F.	500	700-750
Max. rate of evap. per sq.ft., lb.	5	8-15
Max. rate of evap. per boiler, lb.	30,000	400,000
Volume of setting, cu.ft.	7,650	90,000

While it appears that the last word in design has been written into specifications, and while recent installations, notably the Edgar (formerly Weymouth) and Detroit stations, mark a high line in boiler achievement, there still remain a number of details in design and practice of sufficient importance to warrant a considerable amount of investigation and study. These are higher refractory linings, boiler tube endurance, and insulation against heat losses.

Marked Improvement in Tubes

One of the greatest achievements of late has been the progressive improvement in tubes. At present open-hearth process tubes are meeting the requirements. These tubes are tough, strong and durable; in addition they offer greater resistance to surface pitting as compared with many of the older types of tubes.

Insulation against heat loss remains one of the problems that must be given much attention by operators. A wall thickness of 22 in. is now common, and air-cooled walls have been advocated. Wall surfaces must be given attention, and the importance of joints, leakage through metal conduits, rods, and other outlets in the furnace should not be overlooked.

Central stations have been pioneers in boiler practice and design in the past. It is natural that they should lead because they, as a class, are large manufacturers of power, and accordingly are most interested in opportunities which will insure a production of this commodity at a lower cost. The reduction in fuel per kilowatt-hour over this period has been considerable.

Whatever changes come in the future (and at present it seems as if they must be along the line referred to), the central stations are the logical agency to initiate and develop cost-saving devices and means.

At present a halt has been called on account of the fact that the limit of structural materials has been reached in design. No one, however, can predict how long this halt will last.

Facts on Synthetic Ammonia

Since at least 80 per cent of all commercial ice and refrigerating plants use ammonia as the working fluid, referigerating engineers are as much interested in the properties of this vapor as steam engineers are in the properties of steam. During the last few years important improvements have been made in manufacturing synthetic ammonia by the method of extracting nitrogen from the atmosphere, a process developed in Germany by Professor Haber, as a result of which the price of anhydrous ammonia has been reduced from 30 cents to 16 cents a pound.

To remove all doubt regarding the quality of synthetic ammonia the New York City Chapter of the National Association of Practical Refrigerating Engineers asked the United States Department of Agriculture for trustworthy information on this subject.

The questions and answers are as follows:

1. Is synthetic anhydrous ammonia so new and untried a product that there is any question about its suitability for use in refrigeration?

Answer: No.

2. Has it been on the American market for any appreciable period of time? If so, how long and to what extent?

Answer: It has been on the American market for between four and five years.

3. Is there any reason why different brands of ammonia should not be mixed in a refrigerating system?

Answer: No.

4. Is there any reason why synthetic ammonia should not be mixed with brands made by other processes?

Answer: No.

5. Is it true that ammonia made by a synthetic process must, by reason of that fact, be a particularly pure product?

Answer: Synthetic ammonia, if properly prepared and handled, ought to be a very pure product. What degree of purity is met in the products being furnished today, as manufactured and handled, can be determined only by actual analysis.

6. Is it true that because synthetic ammonia is made from a mixture of hydrogen and nitrogen gases, there is any danger of explosions?

Answer: No.

7. Is there any possibility of synthetic ammonia being contaminated with pyridine, acetonitrile, acetates, benzol, sulphides and other impurities that may be present in ammonia made from byproduct ammonia liquor?

Answer: No.

8. Is it true that synthetic ammonia is made at relatively high pressures and temperatures and consequently is less liable to decompose at the temperatures and pressures of normal ice-machine operation?

Answer: It is true that synthetic ammonia is made at relatively high pressures and temperatures, but it is not for this reason any more or less liable to decompose at the temperatures and pressures of normal ice-machine operation.

9. Is ammonia made from byproduct ammonia liquor uniform in composition and free from impurities that are objectionable.

Answer: This depends entirely upon the care with which the purification of the ammonia produced is carried out.

10. What impurities are present in ammonia made from byproduct liquor?

Answer: It is our understanding that the substances named in your Question 7 are the ones which sometimes occur from ammonia made by this process.

11. In what quantity are these impurities present?

Answer: These impurities can be reduced to meet specifications. For example, we would refer you to the specifications of the Navy Department.

12. What is the effect of these impurities in the system?

Answer: Two of the most common effects of these impurities in the system are stoppage and corrosion.

13. What impurities are present in synthetic ammonia?

Answer: While this would depend somewhat on the process, I should say that the two impurities most likely to appear would be water and hydrogen, though there is no reason for the latter if any care at all has been taken in its separation.

14. In what quantity are they present?

Answer: Quantities are variable. I cannot cite you any figures because I know of no data on the subject.

15. What is the effect of these impurities in the system?

Answer: The effect of water would be to form ice in the system. The effect of hydrogen would be to collect in the condenser.

16. Will synthetic ammonia evaporate faster or slower than byproduct ammonia?

Answer: The rate of evaporation should be the same in both cases.

17. If so, is its action beneficial or detrimental?

Answer: No difference.

18. Are the physical properties, such as boiling point, latent heat of vaporization, specific gravity, etc., the same for synthetic ammonia and byproduct ammonia?

Answer: The properties should be identical in all cases.

Eighty Thousand Visitors to Power Show Expected

Arrangements have been completed to care for the eighty thousand visitors expected to attend the fourth Power Show in the Grand Central Palace, New York City, during the week beginning November 30. The exposition will include exhibits from more than four hundred manufacturers and will be much more complete than its three predecessors. Lectures will be given on various topics, and these have been arranged to avoid conflict with the programs of the A. S. M. E.

Refrigerating Data Being Prepared

The properties of the brines used in refrigerating plants have been measured by a number of observers, and these results have recently been collected and correlated at the Bureau of Standards, for publication in the International Critical Tables, now being prepared by the National Research Council.

The properties of these brines which have been measured are of use to the engineer in designing or testing a refrigerating plant and are four in number: (1) Density, or weight per cu.ft.; (2) specific heat, or the heat required to raise the temperature of one pound of brine one degree; (3) viscosity; (4) freezing point.

The material ordinarily used to make brines are sodium (ordinary table salt), calcium chloride and magnesium chloride.

Muscle Shoals Minority Report Late

Both the majority and minority reports of the Muscle Shoals Commission will be submitted to Congress, it has been announced at the White House. Prior to that time, however, it is expected that the two reports will be released for publication.

A report last week to the effect that the minority report had been submitted proved to have been erroneous. It is understood to have been the intention of Commissioners Curtis and McClellan to submit the report the middle of the week. When on the point of taking it to the White House, it now develops, the report was taken up for a final word of discussion with one of the Cabinet officers, with whom the President asked the Commission to confer in the formulation of the report. This conference was prolonged unexpectedly in an effort to reconcile certain views of the administration with those of the minority members of the Commission. This is understood to have been unsuccessful. As this is written, the delivery of the minority report is expected hourly.

Hoover Reports Progress and Suggests Changes

The annual report of the Secretary of Commerce, part of which, "Economic Review", was published early in November, was sent to the President on Nov. 30.

The main part of the report is entitled "The Progress in the Elimination of Waste." The report says that great progress has been made during the year in the national movement for elimination of industrial waste. The Department of Commerce, in continuation of its work of the last five years, has devoted much of its activities to this end. Under the head of "Improvement of our Inland Waterways," Paul S. Clapp, special assistant, surveys the necessity of the improvements of these waterways for transportation and for development of power. In the part devoted to "Elimination of Waste Through Enlarged Electrification," a review of the progress of hydro developments, long-distance transmission and the production of power upon a large scale in more economical plants and at more advantageous points and its effect on industry, he says:

"During the last five years there has been a notable advance in the electrification of the country and in the generation and distribution of power. This is being accomplished not only with an enormous saving in fuel, but with large increases in productivity, reduction of physical labor and added comfort in the home. Since 1920 long strides forward have been taken in the development of widespread electrical power systems, which are increasingly becoming the enormous reservoirs of mobile and reliable power for all purposes, upon which in such large measure our national progress depends. The cost of power has been maintained at pre-war levels, the large economies in production and distribution offsetting the rise in labor and material costs."

The Secretary, in his report, recommends, regarding the Steamboat Inspection Service, that Sections 4433 and 4418 of the Revised Statutes, dealing with the working and hydrostatic pressures of boilers, be amended to conform with modern practice instead of applying the test at 50 per cent in excess of the working pressure, as at present.

He also recommends for this service that Section 4404 of the Revised Statutes be so amended as to include the supervising inspectors in classified civil service, and that the number of supervising inspectors be decreased from 11 to 10.

Reorganization of Executive Departments Forecast

A practical reorganization of the executive departments of the federal government would make possible an annual reduction of $250,000,000 in expenditures, Representative Wood, of Indiana, an influential member of the House of Representatives, believes. He thinks there is small prospect for Congress to agree on legislation specifying the exact form reorganization should take, but he feels there will be no great amount of objection to allowing the President more freedom of action in the grouping of executive agencies so as to secure maximum efficiency.

Sesqui Will Be Started on June 1, Says Mayor

Completion of buildings with an aggregate of 1,250,000 sq.ft. of floor space by June 1 to house exhibits at the Philadelphia Sesqui-Centennial, has been guaranteed by the managers of the exhibition. Assurances to that effect were given last week to the Secretary of State and the Secretary of Commerce by Mayor Kendrick and a delegation from Philadelphia. Everything will be in readiness for the opening on June 1, it was declared.

The President expects to announce promptly the names of the National Advisory Committee which will be the agency through which the co-operation of the federal government will be extended.

Brown-Boveri Increases Its Holdings

The American Brown-Boveri Electric Corp., the new firm in the field of electrical equipment manufacturing, announced on Nov. 24, the acquisition of the Moloney Electric Corp. of St. Louis, a large electrical transformer manufacturer. The corporation's officials also announced the election to the board of William V. Griffin, of the Anthony N. Brady Estate, and Fred Allison, an engineer of the Ford Motor Co.

The purchase of the Moloney Corp., which has been under negotiation for several weeks, adds to the American Brown-Boveri Electric a plant completely equipped for its own line and which maintains its own sales staff, which will be retained. The corporation does an annual business of $2,250,000.

Fred Allison, engineer of the Ford Motor Co., who is recognized in the electrical field as one of Mr. Ford's right-hand men, literally "grew up" with the Ford company. He was assistant to Mr. Ford when he was employed as a sub-station engineer in Detroit.

Important Power Project Proposed in Australia

Specifications are being prepared calling for tenders for a new power house to be erected for the Municipal Council of Sydney, Australia. The program as now outlined calls for the expenditure of about $12,000,000 by the year 1929 for the plant and in laying new mains and putting existing overhead lines under ground. It is planned to have the new power house opened in 1930.

Among the requirements are 6 steam turbines and alternators of 25,000-kw. capacity, 18 boilers of 20,000 lb. evaporation, and also accessories such as pumps, condensers, etc. The undertaking will be financed by a loan floated by the city council. Reference No. 35X. (Trade Commissioner E. G. Babbitt, Sydney.)—*Commerce Reports.*

Bridge River Development To Begin in 1927

Announcement has recently been made by George Kidd, president of the British Columbia Electric Co., that his company has taken over the Bridge River power site and will begin construction in 1927.

The Bridge River project is one of the largest in the northwest.

The ultimate installed capacity will probably be 700,000 hp. Development will take place in five stages, the first being the installation of 54,000 hp. As the demand increases the height of the dam will be increased and additional storage provided. The Bridge River power project was first staked out about 15 years ago.

The power site is about 135 miles from Vancouver, on the Pacific Great Eastern Ry., at a point where Bridge River comes within 2½ miles of Seton Lake at an elevation about 1,200 ft. above it. In general, the plan is to drive a tunnel 12,800 ft. long, which would bring Bridge River water to the top of a 2,800-ft. penstock leading down to a power house on Seton Lake.

Program of the A. S. M. E. Annual Meeting, New York City, Nov. 30 to Dec. 4, 1925

Papers of Interest to Power Plant Field

Monday morning and afternoon —Council meeting; Local Section's Delegates Conference and luncheon; Meeting of Main Committee of Power Test Codes.

Monday evening—Open house.

Tuesday morning—"Centrifugal Compressors for Diesel Engines," by S. A. Moss; "Gas Engines of the Maryland Plant of Bethlehem Steel Co.," by A. A. Raymond; "Internal-Combustion Engine Transmissions," by Hermann Lemp; "The Tension Ratio and Transmissive Power of Belts," by C. A. Norman. Public Hearing on Power Test Codes on Steam Turbines.

Tuesday afternoon — "The Value of Higher Steam Pressures in the Industrial Plant," by William F. Ryan; "The Supply of Industrial Power" by W. H. Larkin, Jr.; Joint Session with the A. S. R. E., "Centrifugal Compression as Applied to Refrigeration," by W. H. Carrier; "The Heat Balance Method of Testing Centrifugal Compressors," by M. G. Robinson; Henry Robinson Towne, Lecture on "Engineering and Economics," by Hon. Herbert Hoover.

Tuesday evening—Award of Honorable Membership to Hon. Herbert Hoover and Worcester R. Warner, past-president of the A. S. M. E., Presidential address and Reception.

Wednesday noon—Luncheon of Council and Student Branch Delegates.

Wednesday afternoon—Annual report of Council; Award of Charles T. Main Junior and Student Prizes; Report of A. S. M. E. Investigation for S. P. E. E. on Mechanical Engineering Education; Steam Tables Research and Research Results by Dr. Keyes of M. I. T. and Dr. Harvey N. Davis, Harvard; Education and Training for the Industries of Non-College Type, Committee on Education and Training for Industries.

Wednesday evening—Annual dinner at Hotel Astor, Dr. Michael I. Pupin, president of the A. I. E. E. and American Association for the Advancement of Science, will be the principal speaker.

Thursday morning — "Radiation in Boiler Furnaces," B. N. Broido; "Recent Developments at Colfax Station," by C. W. E. Clarke; "Steam Bleeding and Turbine Performance," by C. D. Zimmerman; "The Development of a Unit Pulverizer," by R. Sanford Riley and O. Craig; Award of Prizes for papers presented during Oil and Gas Power Week; "Power for Textile Mills," by Charles T. Main.

Thursday afternoon — "Heat Treatment Data on Quality Steel Castings," by A. E. White; "Bolts for Use in Power-Plant Construction," by W. P. Wood; "Boiler Furnace Refractories," by E. B. Powell; "Graphical Study of Journal Lubrication, Part 3," by H. A. S. Howarth; "Charts for Studying the Oil Film in Bearings," by G. B. Karelitz; "Tangential Vibration of Steam Turbine Buckets," by W. Campbell; Robert Henry Thurston Lecture on "Engineering and Science," by Dr. Zay Jeffries.

Friday—Council meeting; Committee meetings, Excursions.

Friday evening—National Defense Division—Speeches by Hon. Dwight F. Davis, Secretary of War; Hon. Hanford MacNider, Assistant Secretary of War, and Gen. James G. Harbord, President, Radio Corp. of America.

New Southern Power Steam Plant Will Be on Yadkin

The Yadkin and not the Catawba River is to be the site of the new steam plant announced some time ago as in contemplation by the Southern Power Co. The company will, according to official statement from Charlotte, N. C., immediately proceed to erect a 75,000-kw. plant on the first-named river two miles from the city of Charlotte.

A part of the machinery for the plant has already been purchased, it is announced, and a part of the building organization is already on the grounds. There will be two turbo-generators of General Electric make. The new plant will be pushed to rapid completion. With its inauguration the Southern Power Co. will have added 210,000 hp. to its generating capacity since the beginning of the present year. This includes the Fort Mill and Rhodhiss hydro-electric plants on the Catawba. The former, rated at 70,000 hp., is nearly completed. The latter, rated at 40,000 hp., was finished last March, but the drought has thus far made it impossible to utilize more than a small part of its capacity. The new steam plant, operating as a reserve, will, the company confidently declares, make a recurrence of the drought conditions of this year impossible.

Devon Plant of Conn. Light & Power Co. To Be Enlarged

The Connecticut Light & Power Co., Waterbury, has decided to install two new boilers of 1,680-hp. rating each at its Devon station, and early in 1926, if load conditions warrant, will purchase a new steam turbo-generator unit. The size of the latter has not yet been determined. Three 25,000-kva. machines are now in service. The Devon station is one of the most important tidewater generating plants in southern New England. It is interconnected with the company's hydro-electric plants at Stevenson and Bulls Bridge, and carries most of the Naugatuck Valley load.

Prince Conti Replies to Congratulations

At a meeting held under the auspices of the Metropolitan Section of the A.S.M.E., in New York City on Nov. 12, to discuss subterranean heat as a source of energy, a message was sent to Prince Ginori Conti at Lardello, Italy, signed by John W. Lieb, chairman of the meeting, and L. P. Breckenridge of Yale, as follows: "The New York branches of our national engineering societies, assembled in joint meeting to discuss the utilization of subterranean heat as a source of power, send you their hearty greetings and felicitations as the world's great pioneer in this new field." In a return cablegram Prince Conti expressed deep appreciation of the compliment paid him.

New Steam Plant Started at Green Bay, Wisconsin

Announcement was made by J. J. Pulliam, general manager of the Wisconsin Public Service Corp., a property belonging to the Byllesby organization, that it will begin work immediately on the construction of a modern steam plant to be located at Green Bay, Wis., at the junction of Green Bay and the Fox River. The new plant will have an initial capacity of 26,800 hp. in two units of equal size and will be thoroughly modern in every respect.

This plant will be interconnected with other steam and hydro plants now in the system, to facilitate the interchange of energy between power sources. The system includes hydro plants at High Falls, Johnson Falls, Caldron Falls, Potash Rapids, and Peshtigo, in Wisconsin, and Ingalls Rapids in Michigan, and steam plants at Green Bay, Manitowoc and Oshkosh. With the completion of the new plant at Green Bay and the Sandstone Rapids hydro development, there will be available 91,800 hp. for this vicinity.

A. S. M. E. Excursion Plans Arranged

Several excursions will be taken by the members and visitors to the annual meeting of the A.S.M.E. One will be an all-day trip by special train to the plant of the Bethlehem Steel Co., Bethlehem, Pa., on Friday, Dec. 4. An observation train will be used at the plant to carry the party through and luncheon will be served by the company.

Other excursions announced are: The De La Vergne Machine Co. and Hell Gate Power Station on Tuesday afternoon, Dec. 1; the New York-New Jersey Vehicular Tunnel on Wednesday morning, Dec. 2, and the Hudson Avenue Power Station on Wednesday afternoon. On Thursday morning, Dec. 3, the 100-ton oil-electric locomotive of the Long Island Railroad will be demonstrated. An alternative trip to the piano factory of Steinway & Sons is also planned. In the afternoon there will be an inspection at Harrison, N. J., of the Edison Lighting Institute, the Worthington Pump & Machinery Corp. and the new waterless holder being built at the Harrison Gas Works.

Dr. von Miller Speaks on Munich Museum

A meeting designed to show the importance, especially in an educational way, of industrial museums in modern life, was held at the Engineering Societies' auditorium, 29 West 39th St., New York City, Nov. 23.

Dr. Oskar von Miller, director of the Deutsches Museum, in Munich, Germany, one of the most important museums in this line in the world, was the speaker of the evening. He told in an interesting way of the ideals and purposes that had been held in mind when the Deutsches Museum was conceived, built and arranged. Historical material had been used where obtainable, and where not models of the original had been arranged in an orderly sequence from the earliest to the latest development of the machine or apparatus, so that the person, after having viewed the exhibit, would go out with the feeling that, after all, it had been an easy thing to accomplish. He pointed out that just collecting historical material was not enough, as no building could ever be large enough to contain it. Descriptions and slides showing how they had worked out the problem in Munich were given, Dr. von Miller especially noting the important arrangement of cross-sectioned and working models of the machines, etc.

Among the things stressed was that the museum should be the workingman's college and the importance of utilizing the eye for study. The Munich museum, he said, was open from early morning until late at night, or during the hours when the workers were free to visit it. A Sunday or holiday crowd often numbered 13,000. He told of how the people as a whole had worked for it by contributing labor and materials of construction during the worst time that the world had ever known and when food was exceedingly scarce. He thought it should be an easy matter to establish a museum in America where we had money.

Dr. John Van W. Reynders, president of the A. I. M. & M. E.; Dr. Charles L. Reese, consulting chemical engineer with du Pont de Nemours & Co., and John W. Lieb, of the New York Edison Co., also made speeches emphasizing the need for such a museum in New York City. Dr. George F. Kunz, of Tiffany & Co., presided, and outlined the functions of an industrial museum.

A telegram was read from Samuel Insull, president of the National Museum of Engineering and Industry, expressing the hope for the speedy construction of the Museum of Peaceful Arts, as the contemplated museum for New York City is called. A set of Johanssen gage blocks, of unusual design, by which differences of .00001 in. may be measured, the gift of Henry Ford, were shown at the meeting. This was the first gift received by the museum.

A. S. R. E. Annual Meeting Program

THE program for the annual meeting of the American Society of Refrigerating Engineers, which is to be held at the Hotel Astor, New York City, Nov. 30-Dec. 2, will contain papers of interest to *Power* readers as follows:

Monday—Presidential address, "A New Era in Refrigeration," by Van R. H. Greene; "Effect of Speed on Compressor Capacity and Power," by L. Howard Jenks, Frick Co.; "Relation of. Specific Heats and Joule-Thomson Coeffi-cien. for Ammonia," by C. S. Cragoe, physicist, Bureau of Standards; "Report of Tests on Welded Pressure Vessels," by L. H. Roller, De La Vergne Machine Co.

Tuesday—"The heat Balance Method of Testing Centrifugal Compressors," by M. L. Robinson, G. E. Co.; "Centrifugal Compression as Applied to Refrigeration," by Willis H. Carrier, Carrier Engineering Corp.; dinner and dance.

Wednesday — "Oil-Engine Driven Ammonia Compression," F. W. Green, Ingersoll-Rand Co.; trips to plants.

Leevining Creek Plant No. 1 Name Changed to Poole Plant

The Southern Sierras Power Co. of Riverside, Calif., has, by resolution at a special meeting of the board of directors, changed the name of one of its power plants to honor the late C. O. Poole, chief engineer of the company. The main part of the resolution declares, "that hereafter the Leevining Creek No. 1 plant shall be designated the Poole plant in recognition of the engineering skill and invaluable services rendered our associated companies by the late Charles Oscar Poole."

New England Engineers To Discuss Fuel Problems

Prominent engineers will discuss the more efficient use of fuel for heating and power uses at a meeting to be held in Huntington Hall, Boston, Mass., Dec. 10 and 11, under the auspices of the Affiliated Technical Societies of Boston.

The opening session will be at 10 a.m., Dr. Ira N. Hollis, former president of the American Society of Mechanical Engineers, presiding. The subject will be "Sources and Utilization of Fuels." At 2:30 p.m. President S. W. Stratton, of the Massachusetts Institute of Technology, will lead a session upon "The Requirements of Power in Industries."

At 10 a.m. on the 11th, I. E. Moultrop, assistant superintendent of construction, Edison Electric Illuminating Co. of Boston, will preside over a meeting on "Operating Practice," and at 2:30 p.m. on that day F. M. Gibson, plant engineer American Sugar Refining Company, Boston, will lead a round table discussion. At 6:30 p.m. a dinner will be held at the New Chamber of Commerce Building, L. E. Moore toastmaster, the speakers being Eugene C. Hultman, chairman of the Massachusetts Commission on the Necessities of Life, and Homer P. Linn, mechanical engineer, Chicago.

Baker River Plant Finished

The large power dam of the Puget Sound Power & Light Co. on the Baker River is now closed and the water piling up behind it. Generation of electricity from Washington's newest hydro plant will take place in the near future. The plant was started in April, 1924. The reservoir, which will be named Lake Shannon in honor of W. D. Shannon, engineer in charge, will be more than 7 miles long and will have a surface area of 1,780 acres. The dam, built across Eden Gorge, is 245 ft. high and 180 ft. thick at the base.

The first two 20,000-hp. turbo-generators are now in place. Its ultimate capacity will be 80,000 hp. The main pressure tunnel has been constructed through the solid limestone of the canyon's side and is 24 ft. in diameter. This tunnel is approximately 1,300 ft. long, lined with concrete. A steel penstock connects the pressure tunnel with the power house. The cost of the undertaking, including a 13,000-kw. substation at Sedro Woolley, is exceeding $8,000,000.

Bureau of Standards Urgently Needs New Power Plant

The Bureau of Standards in its annual report submitted by Dr. Burgess to Secretary Hoover on Nov. 23, states that during the year the Bureau completed 171,196 tests, an increase of 26 per cent over the preceding year. The report says in part:

"To keep pace with the demands of the electrical industry, the Bureau is extending its facilities to measure potentials as high as 350,000 volts, an undreamed of voltage only a few years ago. However, long-distance transmission power projects are now planning the use of high voltages, and so it has become necessary for the Bureau to equip itself for tests in the new voltage range.

"The development of a standard test for elevator interlocks has greatly improved the quality of these devices and has added to the safety of all those using elevators. Insurance companies are offering a 10 per cent reduction in rates on elevators equipped with interlocks which will pass the Bureau's tests, so there is a saving in money as well as life. Air pressures on buildings and chimneys have been studied by means of models in the Bureau's wind tunnels, in which an artificial wind of any desired velocity can be produced.

"Thirty-five simplified practice recommendations have now been accepted, covering a great variety of commodities. Many more are in process of acceptance, and surveys are in progress in many additional fields. The leaders in nine industries which have put simplified practice recommendations into effect estimate a saving of nearly $294,000,000 through this work."

Discussing the needs of the Bureau as disclosed by the rapidly increasing use of its facilities by both public and private institutions, Dr. Burgess says again that a new central power plant is urgently needed.

New Louisiana Steam Plant Opened

The Sterlington steam plant of the Louisiana Power & Light Co. was opened with appropriate ceremonies on Nov. 26-27. State and municipal officials and leading citizens of Louisiana, Mississippi and Arkansas were present. This plant, which is located on the Ouachite River 16 miles above Monroe, La., has an initial installation consisting of two units rated at 15,000 kw. each. The ultimate capacity will be 150,000 kw.

Operating Engineer Wanted by Government

The United States Civil Service Commission has announced an open competitive examination for a first-class steam-electric engineman. Receipts of applications will close Dec. 29. The examination is to fill vacancies in the Office of Public Buildings and Public Parks of the National Capital, in the Indian Service, and in positions requiring similar qualifications. The entrance salary is $1,500 a year. After the probational period of six months required by the civil-service act and rules, advancement in pay may be made without change in assignment up to $1,860 a year. Promotion to higher grades may be made in accordance with the civil-service rules. The duties are to have charge of the operation, maintenance and repair of a large heating, lighting and power plant and all auxiliary mechanical and electrical devices and equipment. Competitors will be rated on their physical ability and training and experience.

Bureau of Mines Reorganizes Its Activities

Effective Dec. 1 the work of the Bureau of Mines will be divided into two major branches, each to be presided over by an assistant director. One will be the technologic branch, with Dr. Dorsey A. Lyon as assistant director in charge. The other will be known as the economic branch, with C. P. White, the assistant director in charge. Scott Turner, the newly elected director, will not take over the duties of his office until Jan. 1.

Under the technologic branch will be grouped the following divisions: Mining experiment stations; safety service; miner's health and sanitation; mechanical engineering; metallurgy and mineral technology; petroleum engineering; explosive engineering; mining research.

The economic branch is new and will deal with the statistical, industrial and commercial phases of coal, metals, other minerals and helium. The branch is subdivided into divisions as follows: Coal; petroleum; helium production; minerals and metals; statistics. The government fuel yard will be administered by the coal division.

It is recognized that the Bureau must be prepared to handle additional coal statistics. The hope is that a plan can be worked out whereby the figures can be submitted on a voluntary basis, or it may be that Congress will require the submission of basic statistics.

McGraw-Hill Co. Buys EMF Electrical Year Book

The McGraw-Hill Co., Inc., has purchased the EMF Electrical Year Book, published by Electrical Trade Publishing Co., Monadnock Block, Chicago. The 1926 edition, which will be out April 1, 1926, will be edited by the staff of the Electrical Trade Publishing Co. and sold by the staffs of both organizations. Headquarters for the Year Book until completion of the 1926 edition will be at the offices of the Electrical Trade Publishing Co., in Chicago, but information and data may be secured from both organizations.

This standard reference book will supplement the service of McGraw-Hill electrical publications by supplying the reference information needed by buyers and specifiers throughout the industry.

Obituary

George Alexander Grubb, national secretary of the Marine Engineers' Beneficial Association since 1898, died on Oct. 9 at his home in Washington, D. C. Mr. Grubb was born 63 years ago in Toronto, Canada. He received his original license as a marine engineer in 1885 and acted as a chief engineer of Lake steamers out of the port of Chicago for a considerable time. He was appointed engineer of the Chicago Avenue water works in 1892 and continued his work there for several years. He was one of the early members of No. 68, Local, M.E.B.A. In 1898 he was elected national secretary of the association and served in that capacity until his death. In 1920, in addition to this secretaryship, he was elected a national treasurer. Mr. Grubb was of a genial nature and had a host of friends not only among marine engineers but in ship operators circles as well. His loss is deeply felt by his many friends. He was a member of the Stationary Engineers Association and the Municipal Employees Society of Chicago as well as having membership in various locals of the M.E.B.A. He leaves a widow and two daughters.

Personal Mention

J. Orvis Keller, head of industrial engineering of the Pennsylvania State College, has been selected to head the extension course in technical industrial engineering, in the same institution.

Jonathan A. Wilson, consulting engineer, ship and engine surveyor, formerly located at 337 Bement Ave., West New Brighton, N. Y., has removed his office to Hampton, Conn.

E. G. Moser, formerly chief operator at the Kalama River plant of the Puget Sound Power & Light Co., Seattle, has been transferred to the company's Baker River plant; **R. Morrow**, second shift operator at the Kalama River plant has been transferred to the Snoqualmie Falls plant, and **E. G. Teagarden**, formerly third shift operator, has been made chief operator at the Kalama plant.

Levi Ballard has left the Philadelphia Electric Co. to become junior engineer at the New York City office of the Vacuum Oil Co.

G. W. Hamilton, turbine engineer, Westinghouse Electric & Manufacturing Co., and a member of the Los Angeles office for the past two years, has been transferred to the Chicago office and will take up his duties there shortly.

Business Notes

The Riley Stoker Corp., Worcester, Mass., has appointed the Engineering Sales Co., Inc., 640 South Peter St., New Orleans, La., as its agent for Louisiana, southern Alabama and southern Mississippi, including Vicksburg, Jackson and Meridan.

The York Oil & Chemical Co., York, Pa., has just been incorporated for the purpose of specializing in the manufacture of oils for the lubrication of ammonia and CO_2 compressors. It is a subsidiary of the York Manufacturing Co. and will market its oils through that company's selling agencies.

The Leavitt Machine Co., Orange, Mass., manufacturers of Dexter valve reseating machines for globe, gate and pump valves, announces the following appointments to cover Northern and Southern Ohio, respectively; The Ashmead-Danks Co., 7016 Euclid Ave., Cleveland, Ohio; Emil Werner, Woodlawn, Cincinnati. The McQuaide Belting Co., 103 Virginia St., Charleston, W. Va., will represent the company in West Virginia.

The Prest-O-Lite Co., Inc., 30 East 42d St., New York City, has recently made some changes in its executive officers: M. J. Carney, formerly president, was elected chairman of the Board of Directors; William F. Barrett, formerly vice-president, was elected to the presidency; Ralph R. Browning was elected vice-president in charge of acetylene sales, and R. J. Hoffman was re-elected vice-president in charge of storage battery and automotive divisions.

The Taylor Stoker Co., Ltd., and the **Cleaton Co., Ltd.,** both of which concerns have been doing business in Canada for over ten years, have, with a view to creating an organization of broad scope, in both general sales and engineering service in steam, hydraulic and industrial plant equipment, now been merged with the Affiliated Engineering Companies, Ltd. The headquarters of the company are in the Southam Bldg., Montreal. Its officers are: F. S. B. Heward, president; R. E. Cleaton, vice-president and secretary; C. L. Cushmore, treasurer; M. Alpern, chairman of the board.

Trade Catalogs

Buckets, Clam Shell—The Hayward Co., 50 Church St., New York City. Bulletin No. 650 describes with appropriate illustrations class "E" clam shell buckets which are of the power wheel type.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Institute of Chemical Engineers—Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Sinton Hotel, Cincinnati, Ohio, Dec. 2-5.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 4.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30.

National Association of Practical Refrigerating Engineers. Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

National Research Council, Engineering Division. William Spraragen, 29 West 39th St., New York City. Fifth annual meeting at Washington, D. C., Dec. 3-4.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Blowers & Exhausters—Allen & Billmyre Co., Inc., 730 Grand Central Palace, New York City. Bulletin No. 130 describes and illustrates the "Tabco" blowers and exhausters, multistage centrifugal type, made by this firm.

Laboratory Standards—The General Electric Co., Schnectady, N. Y. Bulletin GEA-100 published in August, supersedes Bulletin 46067. It covers laboratory standards Type PL-2, alternating current and Type DL-2, direct current.

Belt Drive—The Allis-Chalmers Co., Milwaukee, Wis. A bulletin recently issued, No. 1228, gives descriptions of this flexible and positive multiple-belt drive for close centers. Good photos, formulas and diagrams for arriving at estimates and layouts of this "Texrope" drive are included.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Nov. 23 1925
Pool 1	New York	$2 75@$3.00
Smokeless	Boston	2.55
Clearfield	Boston	1.90@ 2.40
Somerset	Boston	2.00@ 2.50
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.10@ 2.25
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.75@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	....

FUEL OIL

New York—Nov. 25, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal.; 36@40 deg., 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 19, tank-car lots, f.o.b St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.4c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Nov. 12, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.

Dallas—Nov. 14, f.o.b. local refinery; 26@30 deg., $1.45 per bbl.

Philadelphia—Nov. 19, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.70@$1.76; 13@19 deg., $1.60@$1.66 per bbl.

Boston—Nov. 16, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Nov. 17, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6¼c. per gal.

Chicago—Nov. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Calif., Los Angeles—Glacier Palace Ice Skating Association, 1547 North Western Ave., awarded contract for the construction of an ice skating rink at Clinton St. and Van Nuys Ave. to Malcolm Smith Co., 6665 Sunset Blvd. Estimated cost $80,000.

Calif., San Francisco—J. T. Ludlow, 460 Montgomery St., Engr., is preparing plans for the construction of an ice skating rink on 48th Ave. Estimated cost $600,000. Owner's name withheld.

Calif., Soldiers Home (Sawtelle P. O.)—National Home for Disabled Volunteer Soldiers, Pacific Branch, will receive bids until Jan. 18, 1926 for the construction of a hospital including mechanical equipment and elevators. C. W. Wadsworth, Gen. Treas.

Calif., South Pasadena — City plans an election to vote $450,000 bonds for waterworks improvements including the installation of pumping plants, reservoirs, mains, etc. Olmstead & Gillelen, Hollingsworth Bldg., Los Angeles, are engineers.

Colo., Denver—Continental Oil Co., Continental Oil Bldg., awarded contract for the construction of a 10 story office building at 18th and Glenarm Sts. to G. M. Tamblyn, Sweeney Bldg. Estimated cost $1,000,000.

Conn., Hartford—One Hundred Eighteen Observation Squadron Connecticut National Guard, awarded contract for the construction of an armory including central heating plant on Brainard Field to Bartlett-Brannard Co., Inc., 252 Asylum St. Estimated cost $60,000.

Fla., Tampa—Citizens Ice Corp., plans the construction of a 60-ton ice plant at North Ave. and Oak St. Estimated cost $75,000.

Fla., Tampa—Tampa Artic Co., B. A. Burford, Jr., Pres., plans the construction of a 100-ton ice plant. Estimated cost $225,000.

Ill., Chicago—Edgewater Athletic Club, 105 West Monroe St., will receive bids about Jan. 1 for the construction of a 15 club including swimming pool, ice storage room, refrigerating machinery, three 200 Heine type boilers, ventilators, 2 passenger and 1 freight elevator, etc., at Sheridan Road and Ardmore Ave. Estimated cost $3,500,000. P. Gerhardt, 64 West Randolph St., is architect.

Ill., Chicago—C. F. Henry and J. H. Buttas of B-W Construction Co., 720 Cass St., will soon award contract for the construction of a 12 story apartment at 55th St. and Hyde Park Blvd. Estimated cost $1,500,000. Lowenberg & Lowenberg, 111 West Monroe St., are architects.

Ill., Chicago—H. O. Stone & Co., 6 North Clark St., awarded contract for the construction of a 15 story apartment at 1320 North State St. to Hegeman-Harris Co., 431 North Michigan Ave. Estimated cost $1,000,000.

Ill., Granite City—Midland Coke & Iron Corp., 117 North Fourth St., St. Louis, Mo., has taken over the properties of the St. Louis Coke & Iron Corp. and awarded contract for the construction of an electric power plant of two 5,000 kw. units also a blast furnace 3,500 ton steel capacity to Riter-Conley Co. Inc., Oliver Bldg., Pittsburgh, Pa. Estimated cost $2,500,000.

Ill., Granite City—St. Elizabeth Hospital will soon receive bids for the construction of a 4 story hospital on Madison Ave. Estimated cost $500,000. V. J. Klutho, Syndicate Trust Bldg., St. Louis, Mo., is architect.

Mich., Detroit—Briggs Development Co., W. O. Briggs, 11631 Mack Ave., awarded contract for the construction of a 5 story apartment including steam heating system on Covington Drive to Bryant & Detwiler, 2336 Dime Bank Bldg. Estimated cost $500,000.

Mich., Detroit—M. Hamburger, 5815 Brush St., is having plans prepared for the construction of a 12 story hotel including steam heating equipment on Cass Ave. Estimated cost $2,000,000. Private plans.

Mich., Highland Park (Detroit P. O.)—Highland Building Corp., c/o Spencer, White & Prentis Co., 1200 Washington Boulevard Bldg., Detroit, is having plans prepared for the construction of a 5 story apartment including steam heating boilers and equipment on Bartlett Ave., here. Estimated cost $3,000,000. L. Chesnow, 333 State St., Detroit, is architect.

Minn., Madison — City plans improvements to waterworks system including deep wells, reservoir, pumping equipment, etc. Estimated cost $35,000.

Minn., New Prague—City is having plans prepared for the remodeling of electric power station from d.c. to a.c., and extension to distribution system. Estimated cost $50,000. J. H. A. Brahtz, 601 Builders Exchange Bldg., St. Paul, is engineer.

Miss., Moss Point—City plans an election Dec. 1 to vote $135,000 bonds for improvements to waterworks including a 300,000 gal. reservoir, 100,000 tank on tower, 800 ft. well, oil burning engines, pumps, etc. H. A. Mentz, Hammond, La., is engineer.

Mo., Kansas City — Armour-Warwick Blvd., A. B. Young, Pres., 3619 Broadway, awarded contract for the construction of a 12 story hotel at Broadway and Valentine Blvd. to Fleming-Gilcrist Construction Co., 320 New York Life Bldg. Estimated cost $1,600,000.

Neb., Grand Island—H. E. Clifford, will receive bids until Dec. 15 for one or two 700 hp. water tube boilers and mechanical stokers for water and power plant. Estimated cost $22,500 each and $11,500 each respectively. Pillsbury Engineering Co., 2344 Nicollet Ave. S., Minneapolis, Minn., is engineer.

Neb., Lincoln—City is having plans prepared for the construction of a power plant two complete units to be installed with room provided for a third unit later. Estimated cost $75,000. J. R. Betts, c/o Diesel Engine Electric Co., is engineer.

Neb., Omaha—City Ice & Fuel Co., 1935 Euclid Ave., will soon award contract for enlarging and remodeling of ice plant to increase capacity to 250 tons daily. Estimated cost $100,000. Electric equipment for freezing room will be required.

N. J., Asbury Park—Asbury Park Comrs., A. G. King, Clk., plans the construction of a heating plant in municipal pavillion on Sunset Ave. Estimated cost $20,000. N. Rogers, is architect.

N. J., Gloucester—Forest Mercerizing Co., will soon award contract for addition to plant including boiler house, etc. on Essex St. C. E. Wunder, 1520 Locust St., Philadelphia, Pa., is architect.

N. Y., New York—Ellban Realty Corp., c/o Schwartz & Gross, 347 5th Ave., Archts., is having plans prepared for the construction of a 14 story apartment at Park Ave. and 80th St. Estimated cost $1,400,000.

N. Y., New York—A. E. Lefcourt, 1351 Broadway, plans the construction of a 23 story loft building at 7th Ave. and 23rd St. Estimated cost $7,000,000. Architect and engineer not selected. Work will be done by separate contracts under the supervision of owner.

N. Y., New York—One Hundred Seventeen Liberty Street Corp., c/o Walker & Gillette, 128 East 37th St., Archts., and Engrs., is having plans prepared for the construction of a 17 story office building. Estimated cost $1,000,000.

N. Y., New York—Three Thousand Eight Hundred Fifty Four Corp., c/o E. Roth, 119 West 40th St., Archt. and Engr., is having plans prepared for the construction of a 19 story hotel at 26 West 54th St. Estimated cost $1,500,000.

N. Y., New York—H. H. and P. Uris, 553 West 26th St., is having plans prepared for the construction of a 21 story office building on Lafayette and Read Sts. Estimated cost $2,000,000. Buchman & Kahn, 49 West 45th St., are architects and engineers.

N. C., Norwood—Carolina Power & Light Co., P. A. Tillery, Gen. Mgr., Raleigh, plans a hydro-electric development including an 80 ft. dam across the Yadkin River near here.

Okla., Kingfisher—City plans an election Dec. 8 to vote $40,000 bonds for the installation of a 1,000 kw. steam turbine generator for municipal light plant. W. Ash, is engineer.

Tenn., Bristol—Bristol Gas & Electric Co., subsidiary of Cities Service Co., H. L. Doherty & Co., 60 Wall St., New York, N. Y., plans the construction of a hydro electric plant on the Wautauga River, here. Estimated cost $500,000.

Tex., Abilene—State Bd. of Control, c/o S. B. Cowell, Chn., Austin, and T. B. Bass, Abilene, is having plans prepared for the construction of a 10 ton ice plant for state hospital here. Estimated cost $25,000. W. Nichol and G. Campbell, 29-30 Radford Bldg., Abilene, are engineers. Complete equipment will be required.

Tex., Amarillo—City plans an election Dec. 21 to amend charter making $1,750,000 bond issue legal. Bonds were voted for waterworks improvements including a 3,000,000,000 gal. storage reservoir, 5,000,000 gal. distribution reservoir, six 1,000 g.p.m. deep well and two 3,000 g.p.m. horizontal pumps, etc. J. D. Bartlett, City Mgr. H. B. Jones, Amarillo, is engineer.

Tex., Beaumont—Josey Ice & Coal Co., awarded contract for the construction of an ice plant to H. Weber, 311 Perlstein Bldg. $22,000.

Tex., Colorado—Colorado Ice Co., c/o L. J. Geer, Sweetwater, will build a 20 ton ice plant and cold storage warehouse here by day labor. Estimated cost $100,000. Private plans. Machinery for complete ice plant will be required.

Tex., Denton—Crystal Ice Co., plans the construction of a 25 ton ice plant. Estimated cost $60,000. Private plans. Machinery will be required.

Tex., Sweetwater — Sweetwater Ice & Cold Storage Co., will build an addition to ice and cold storage plant by day labor to increase capacity of plant 30 tons daily. Estimated cost $150,000. Private plans. Machinery for a 30 ton plant will be required.

Tex., Wichita Falls—W. F. Parish is having plans prepared for the construction of a 7 story office building at 8th and Lamar Sts. Estimated cost $450,000 to $500,000. Sanguinett, Staats, Hedrick & Pate, First National Bank Bldg., Ft. Worth, are architects.

Va., Virginia Beach—Virginia Beach Hotel Corp., c/o Neff & Thompson, Seaboard National Bank Bldg., Norfolk and George B. Post & Sons, 101 Park Ave., New York, N. Y., Archts., will soon award contract for the construction of a 7 story hotel here. Estimated cost $1,000,000.

Va., Yorktown—Yorktown Manor Hotel Corp., c/o J. H. MacDowell, Bulkley Bldg., Cleveland, O., Archt., awarded contract for the construction of a 4 story hotel to A. A. Lane Construction Co., 1860 East 55th St. Estimated cost $1,000,000.

Wis., Green Bay—Byllesby Engineering & Management Corp., 231 South La Salle St., Chicago, Ill., is receiving bids on the structural steel for the proposed steam power plant here, for Wisconsin Public Service Corp. Estimated total cost $2,000,000.

Wis., Milwaukee—Chain Investment Co., c/o Rosman & Wierdsma, 490 Broadway, N. Y., Archts., will soon award contract construction of an 8 story apartment on Grand Ave. Estimated cost $600,000.

Wis., Milwaukee—R. Cramer, 1105 Uliet St., Engr., is receiving bids for the construction of a 3 story laundry and power house for Milwaukee Hospital, 22nd and Cedar Sts. Estimated cost $60,000.

N. Z., Wellington—Public Works Supplies and Tenders Committee, will receive bids until Jan. 26, 1926, for Waikato Power Scheme, Sect. 131, two 110 kv. oil immersed circuit breakers, 5 sets of airbrake switches, 8 sets of isolating switches, 2 operating sticks for isolating switches, insulators, spares, etc., for Hamilton substation. Sect. 144, 250,000 v. 50 amp. and 50,000 v. 120 amp. automatic oil switches, 50,000 v. 120 amp. non-automatic oil switch, six 50,000 v. single pole isolating switches for horizontal mounting, 1 switchboard panel, spares, 3 oil switch terminals, 3 current transformers, etc. Sect. 145, 2 sets of 50,000 v. lightning arresters and accessories for Waikino substation. Sect. 191, four 4,000 kva. transformers single phase units to form 12,000 kva. bank 66,000/11,400 v. delta star connected with one spare unit. Lake Coleridge Electric Power Scheme.

Ont., Kleinburg—Hydro-Electric Power Comn., 190 University Ave., Toronto, has had plans prepared for the construction of an outdoor type transformer station here, three 125 kva. transformers. T. A. Gaby, 190 University Ave., Toronto, is engineer